# Update of Frozen Showers

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DESY - ATLAS
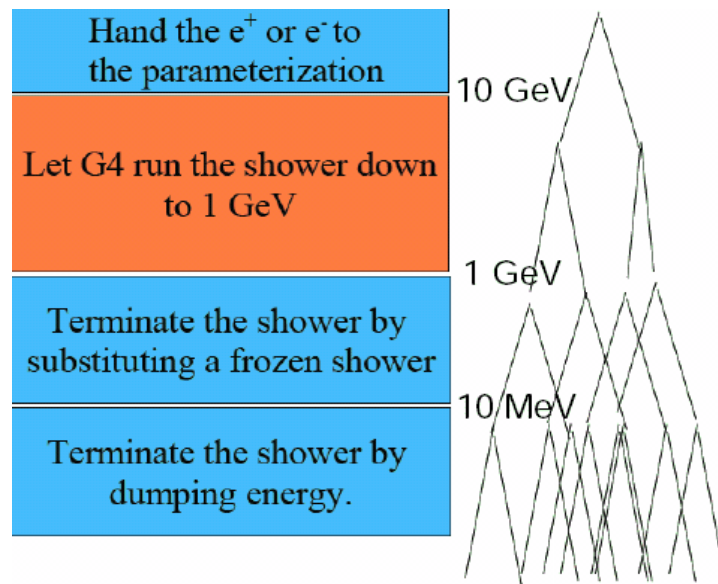
- Reminder: Frozen Showers (FS)
- FS validation against release 13
- Studies of photon shower library performance
- Summary

# Reminder: Frozen Showers (FS)

- Frozen Shower Library (FS):
  - full simulation down to 1 GeV cut-off
  - pre-stored shower library of compressed GEANT4 hits

Must satisfy requirements:

- speed-up MC simulation
- good shower shape description with respect to full simulation



| | |
|---|---|
| Hand the $e^+$ or $e^-$ to the parameterization | 10 GeV |
| Let G4 run the shower down to 1 GeV | |
| Terminate the shower by substituting a frozen shower | 1 GeV |
| Terminate the shower by dumping energy. | 10 MeV |

Presently FS are being tested in 13.0.10 release with re-generated shower libraries (this talk)

# Performance of FS: **EMB** with new libraries in r13.0.10

— full simulation (e of 64 GeV, $\eta$=0.25)
- FS < 1 GeV < full simulation
- FS < 1 GeV < full sim < 12 GeV < parametrisation
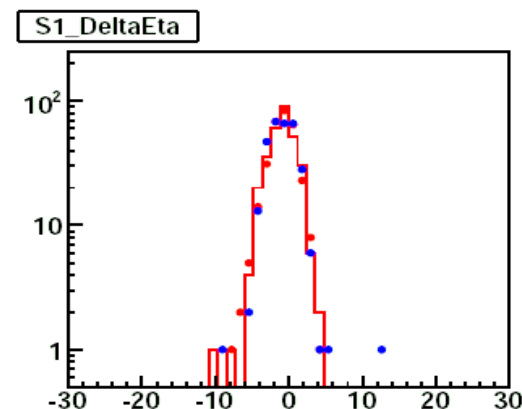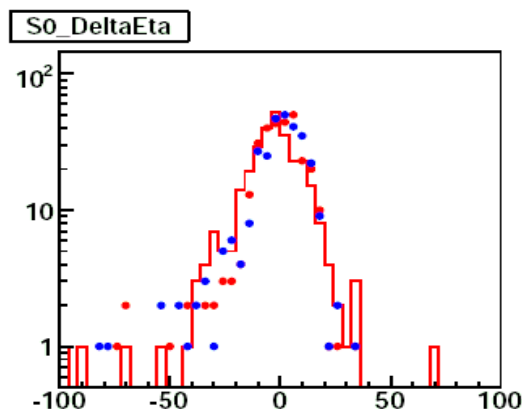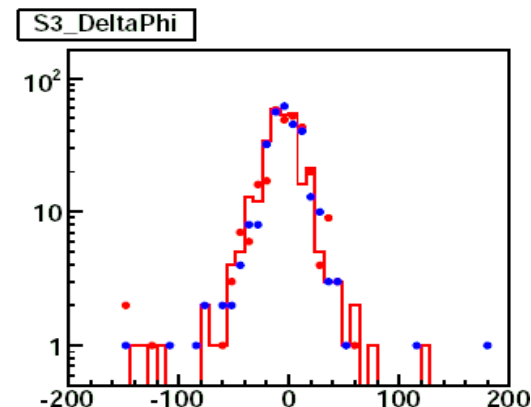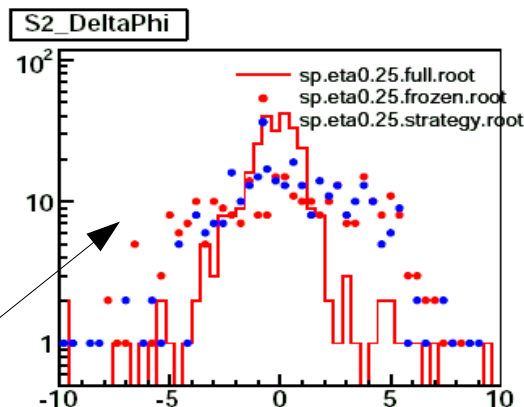
**Deposited_Energy**

remaining shift ~1%
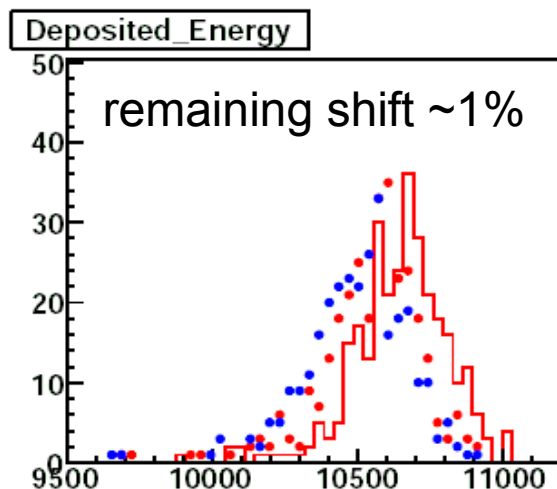
Small discrepancy in $\Delta\phi$
of second compartment
(not yet understood)

average time per event:
| | |
|---|---|
| full sim | 17.9±0.03 s |
| FS | 0.97±0.02 s |
| param | 0.97±0.02 s |

**S2_DeltaPhi**

sp.eta0.25.full.root
sp.eta0.25.frozen.root
sp.eta0.25.strategy.root

**S3_DeltaPhi**

**S0_DeltaEta**

**S1_DeltaEta**
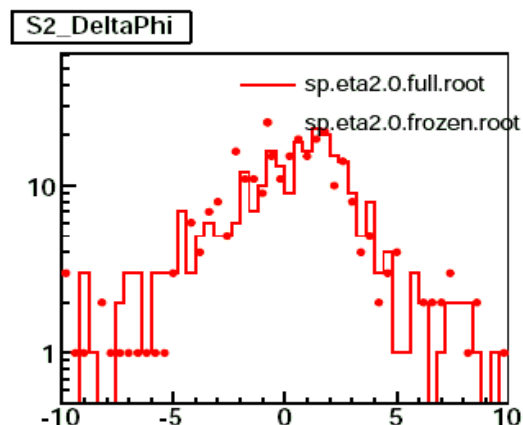
Only generator variables are presented, reconstruction is not yet available

— full simulation (e of 64 GeV, $\eta$ = 2.0)
• FS < 1 GeV < full simulation
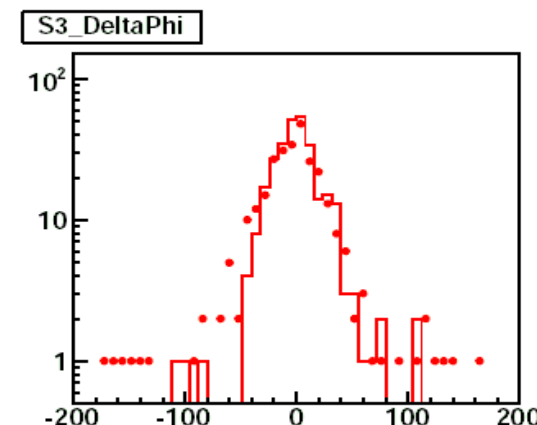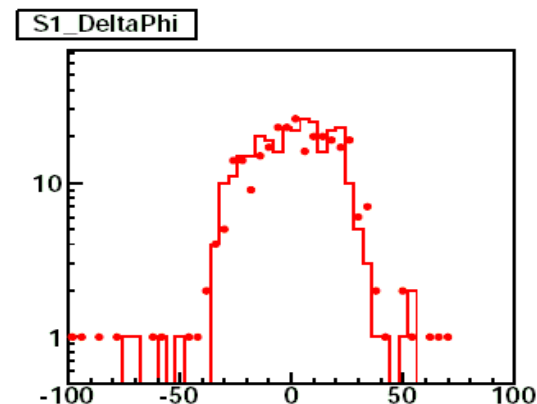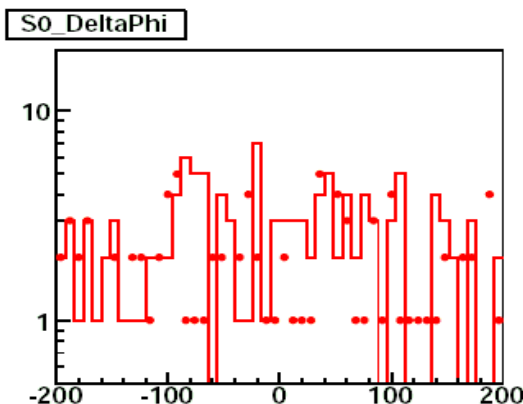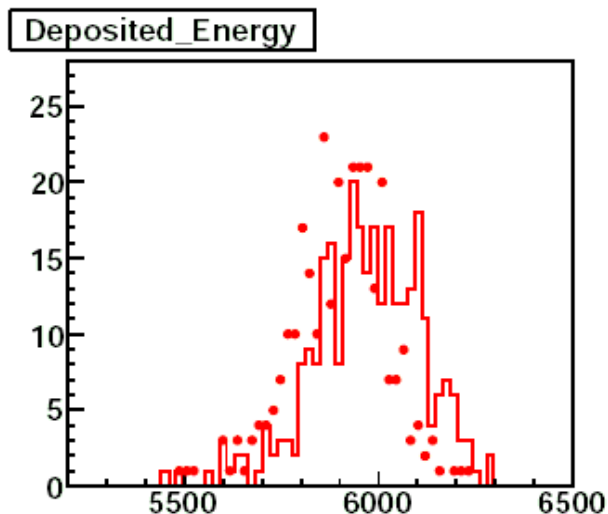


average time per event:

| | |
|---|---|
| full sim | 47.4±0.07 s |
| FS | 1.76±0.04 s |

good description

# Performance of FS: FCAL1 with new libraries in r13.0.10

— full simulation (e of 64 GeV, $\eta$ = 3.5)
- FS < 1 GeV < full simulation

**Deposited_Energy**
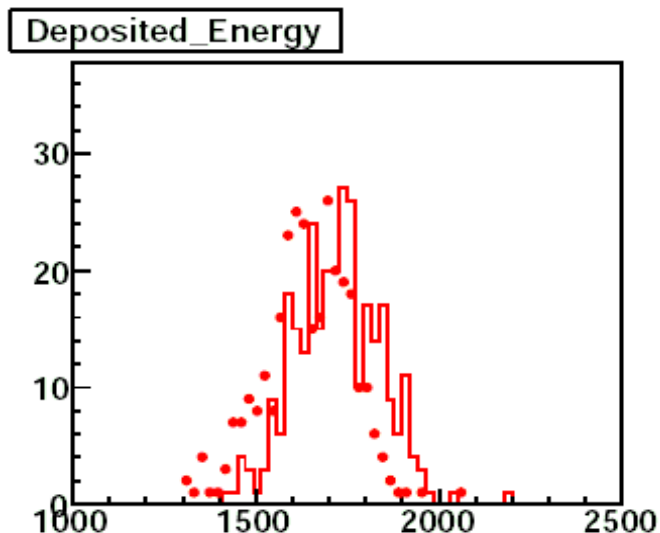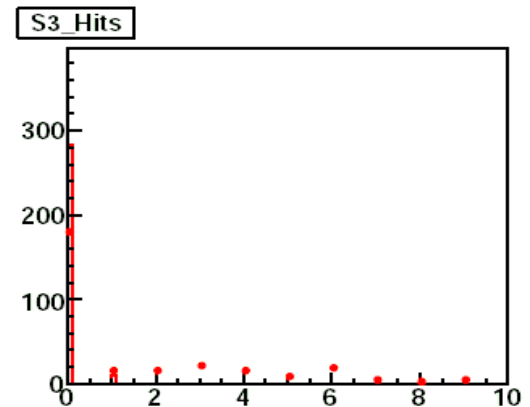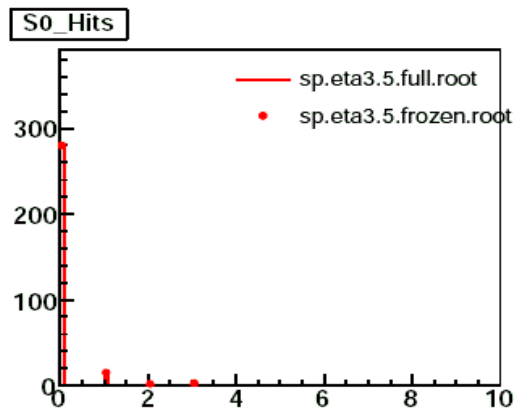
**S0_Hits**

sp.eta3.5.full.root
· sp.eta3.5.frozen.root

**S1_Hits**

**S2_Hits**

**S3_Hits**

average time per event:
| full sim | 9.6±0.01 s |
| FS | 0.54±0.02 s |

good description

Dijet spectrum numbers

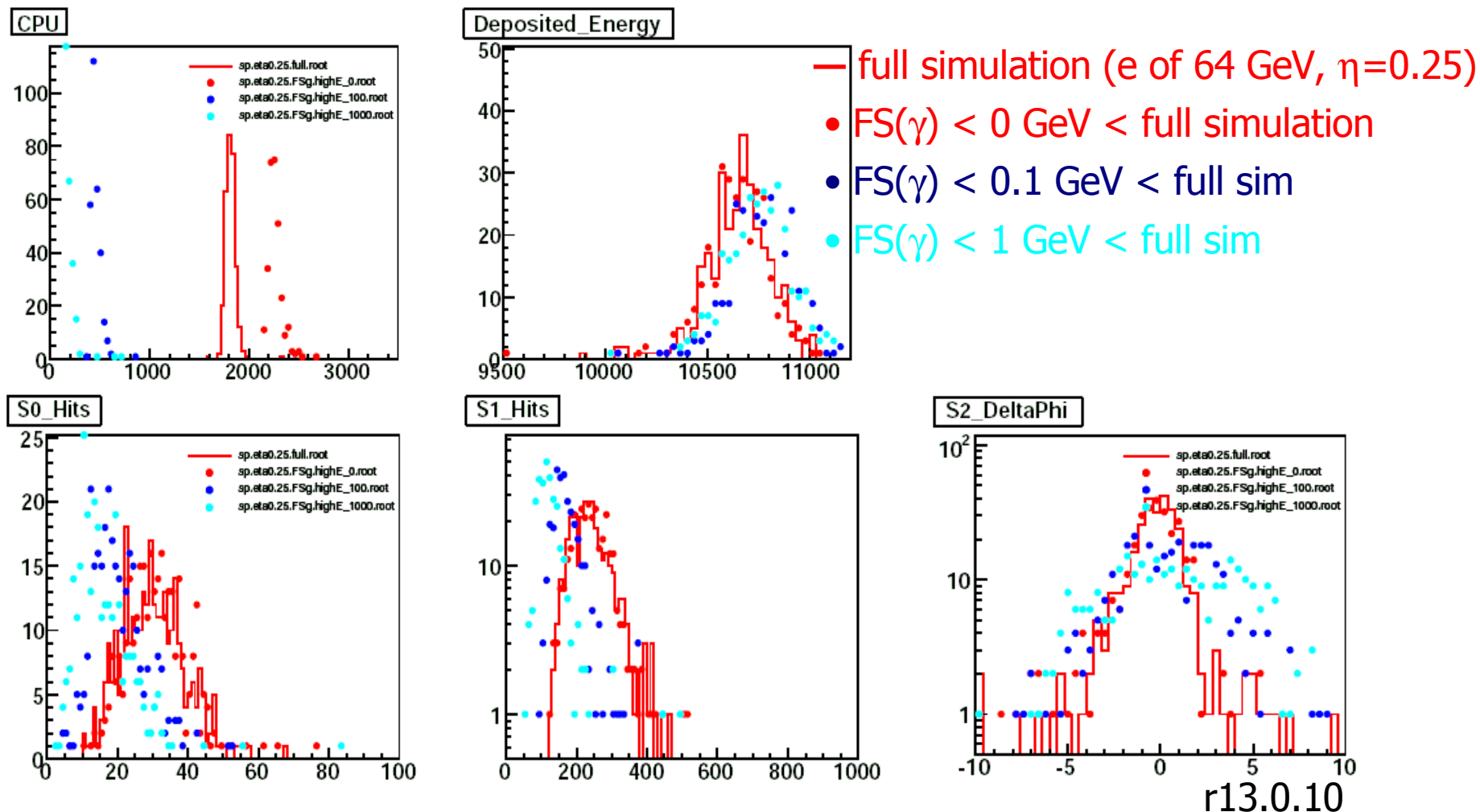| Energy range | Photons | $e^{\pm}$ | Other particles |
|---|---|---|---|
| Up to 10 MeV | 57582.9 | 2266 | 12 |
| 10 MeV-1 GeV | 3834.7 | 1971.4 | 3387.2 |
| 1-10 GeV | 91.2 | 64 | 529.3 |
| From 10 GeV | 9.6 | 6.3 | 39 |

← low energy photons dominate, interesting region to parametrise

tested following combinations:

- various upper energy thresholds for photon library

- combination of FS for electrons with FS for photons

# Photon shower library

Comparison of various upper energy limits for photon library



full simulation (e of 64 GeV, $\eta$=0.25)

FS($\gamma$) < 0 GeV < full simulation

FS($\gamma$) < 0.1 GeV < full sim

FS($\gamma$) < 1 GeV < full sim

r13.0.10

# Photon shower library: FS(e) together with FS($\gamma$)

— full simulation (e of 64 GeV, $\eta$=0.25)

average time per event:

- FS(e) and FS($\gamma$) < 0 GeV < full simulation    17.9±0.03 s
- FS(e) and FS($\gamma$) < 0.1 GeV < full sim    0.97±0.02 s
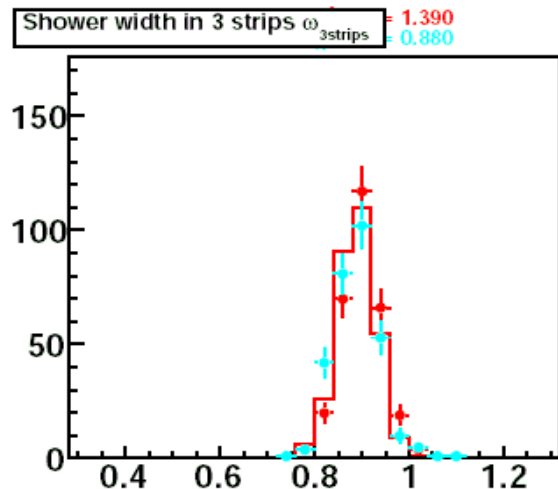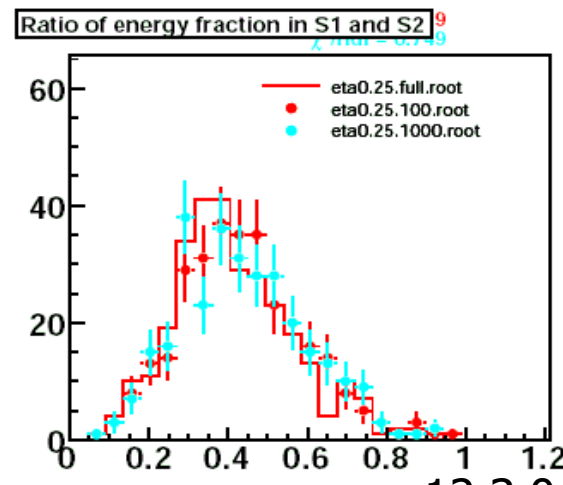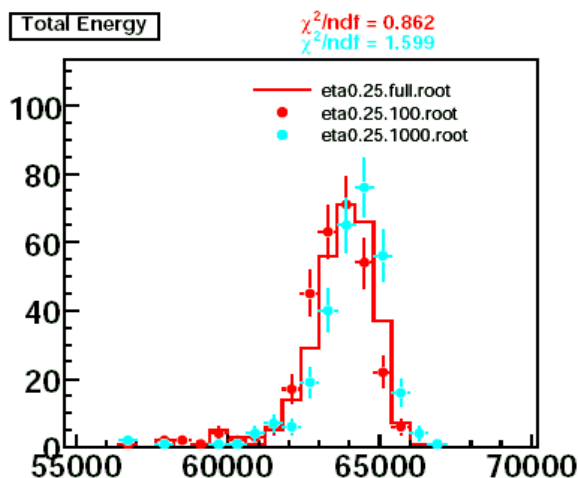- FS(e) and FS($\gamma$) < 1 GeV < full sim    0.76±0.03 s
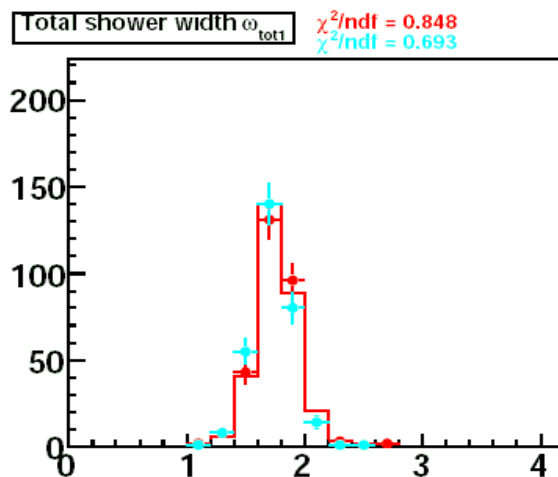
0.72±0.02 s ⟵ best perfor-mance
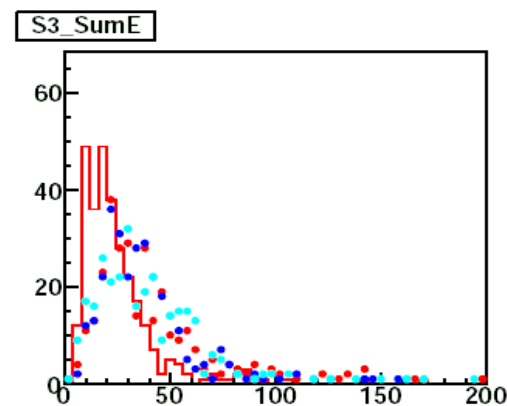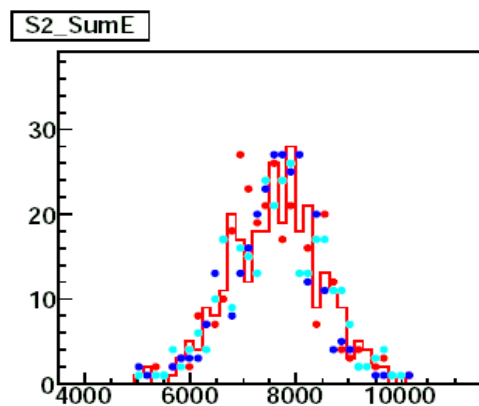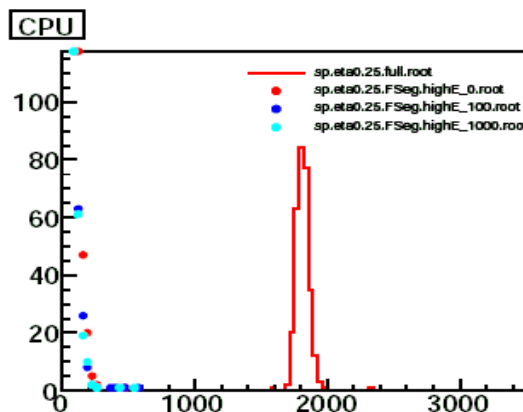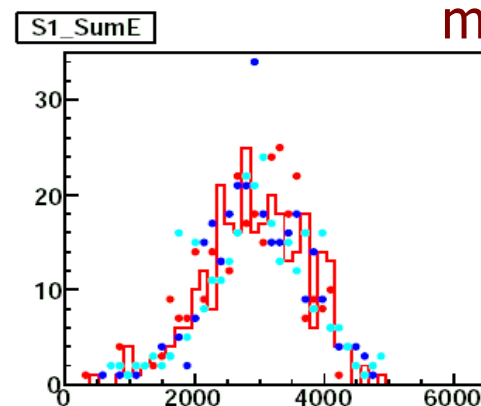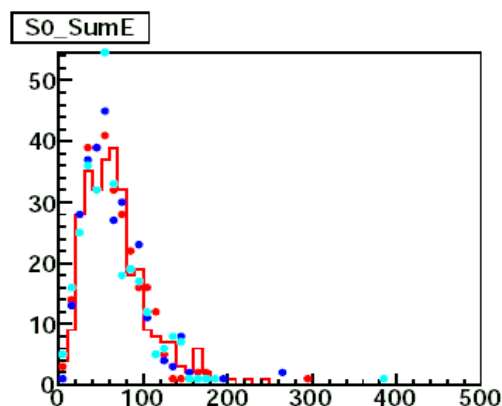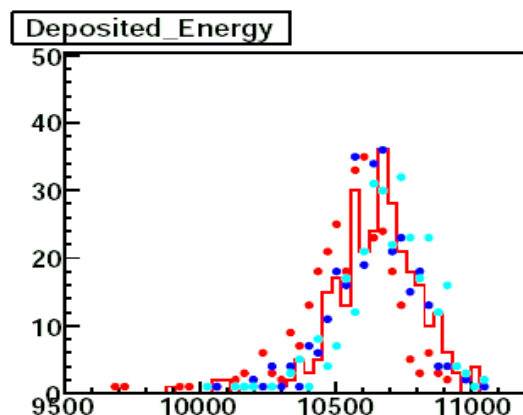
# Photon shower library: reconstruction level (r12.3.0)
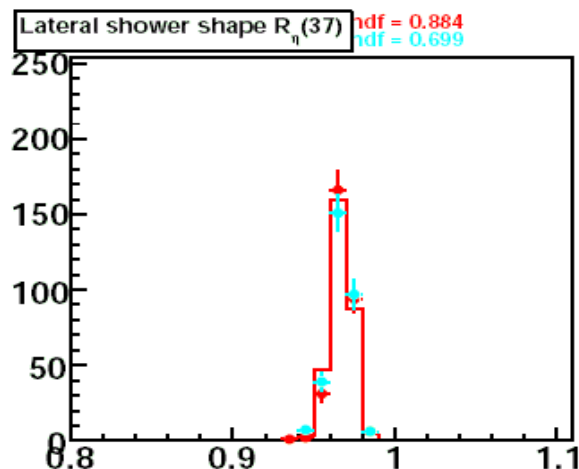


— full simulation (e of 64 GeV)

• FS(e) and FS($\gamma$) < 0.1 GeV

• FS(e) and FS($\gamma$) < 1 GeV

r12.3.0

# summary

The fast simulation of electromagnetic showers (Frozen Showers) is being tested in 13 release:

- FS show expected performance (against 12.3.0)

- the infrastructure of FS for photons is implemented and tested (few tests still to be completed)

- large scale validation of FS to be carried out together with performance and physics groups