Shower Simulation

DESY ATLAS Meeting

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- **Timing of Physics Events**
- **Validation**
- **Low Energy Electrons**
- **Shower Library**

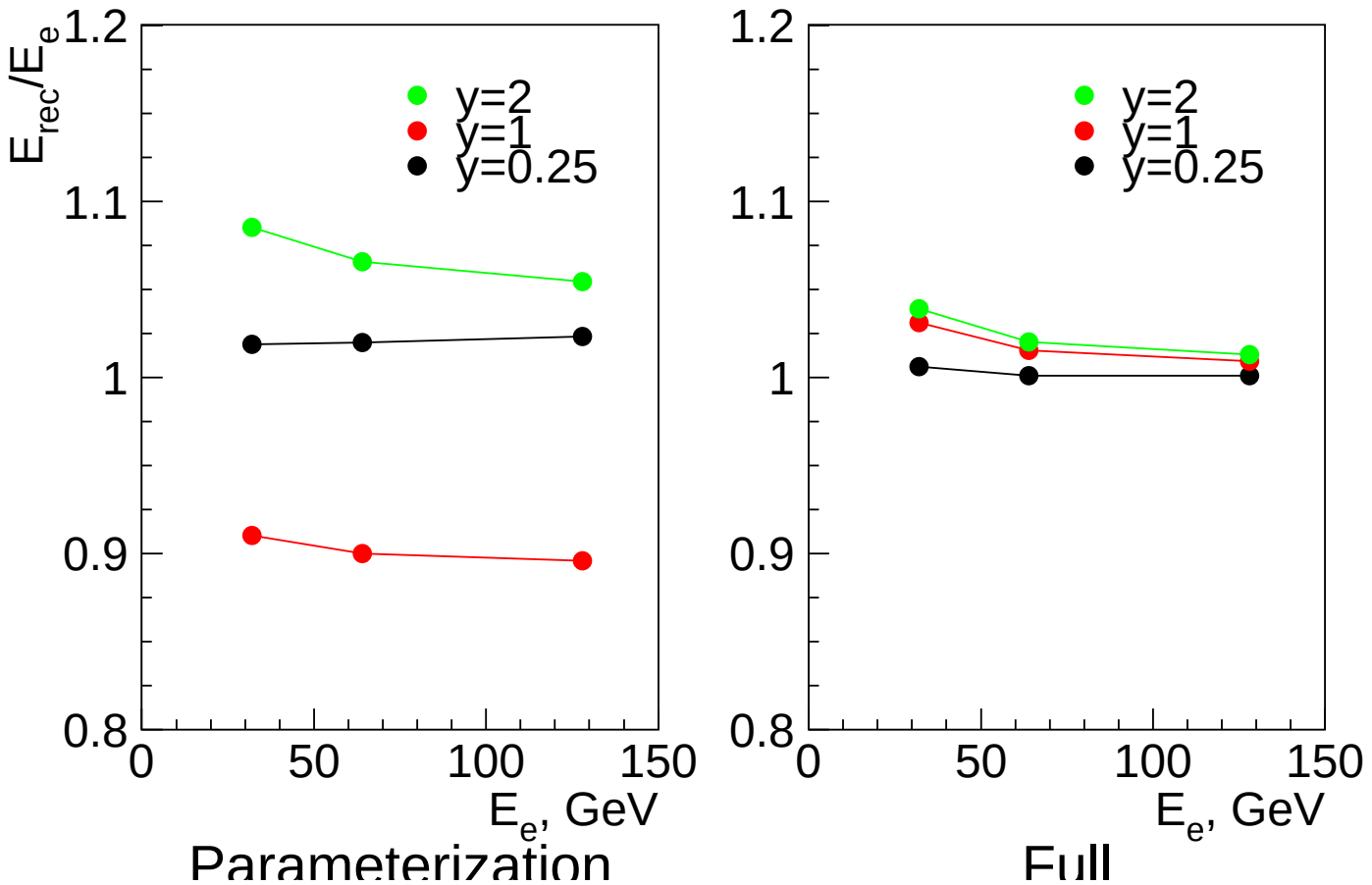
Timing of Simulation: Physics Events

Time / Event	e B		e EC		e FC		Higgs		Zee	
Dead Time	3%	4%	2%	3%	4%	4%	5%	5%	4%	4%
Pixel	0%	0%	0%	0%	0%	1%	0%	1%	0%	1%
Tracker	2%	7%	1%	3%	0%	1%	5%	7%	3%	4%
EMB (P)	35%	32%	2%	1%	0%	0%	3%	2%	2%	1%
EMB	53%	40%	3%	3%	0%	0%	5%	3%	3%	2%
EMEC (P)	0%	0%	83%	72%	15%	15%	23%	15%	30%	20%
EMEC	0%	0%	2%	4%	2%	2%	2%	1%	1%	1%
FC1 (P)	0%	0%	0%	0%	48%	45%	15%	15%	19%	16%
FC23 (P)	0%	0%	0%	0%	1%	1%	4%	4%	3%	3%
FC	0%	0%	0%	0%	12%	10%	7%	7%	7%	6%
HCB	0%	0%	0%	0%	0%	0%	2%	3%	1%	2%
HCEC	0%	0%	1%	0%	1%	1%	2%	3%	2%	2%
Mu	0%	0%	0%	0%	1%	1%	10%	13%	9%	17%
Lar	0%	1%	2%	2%	5%	6%	3%	3%	3%	3%
Cryostat	1%	3%	2%	3%	7%	7%	6%	6%	5%	6%
Presampler	3%	8%	1%	1%	0%	0%	1%	1%	1%	1%
InDetServMat	0%	1%	0%	1%	0%	0%	1%	1%	1%	1%
”Other”	1%	4%	1%	4%	3%	6%	8%	10%	6%	10%
Total	244s	56s	418s	118s	251s	127s	7156s	4719s	776s	470s

full Simulation — fast simulation

Numbers from Zach Marshall/SLAC

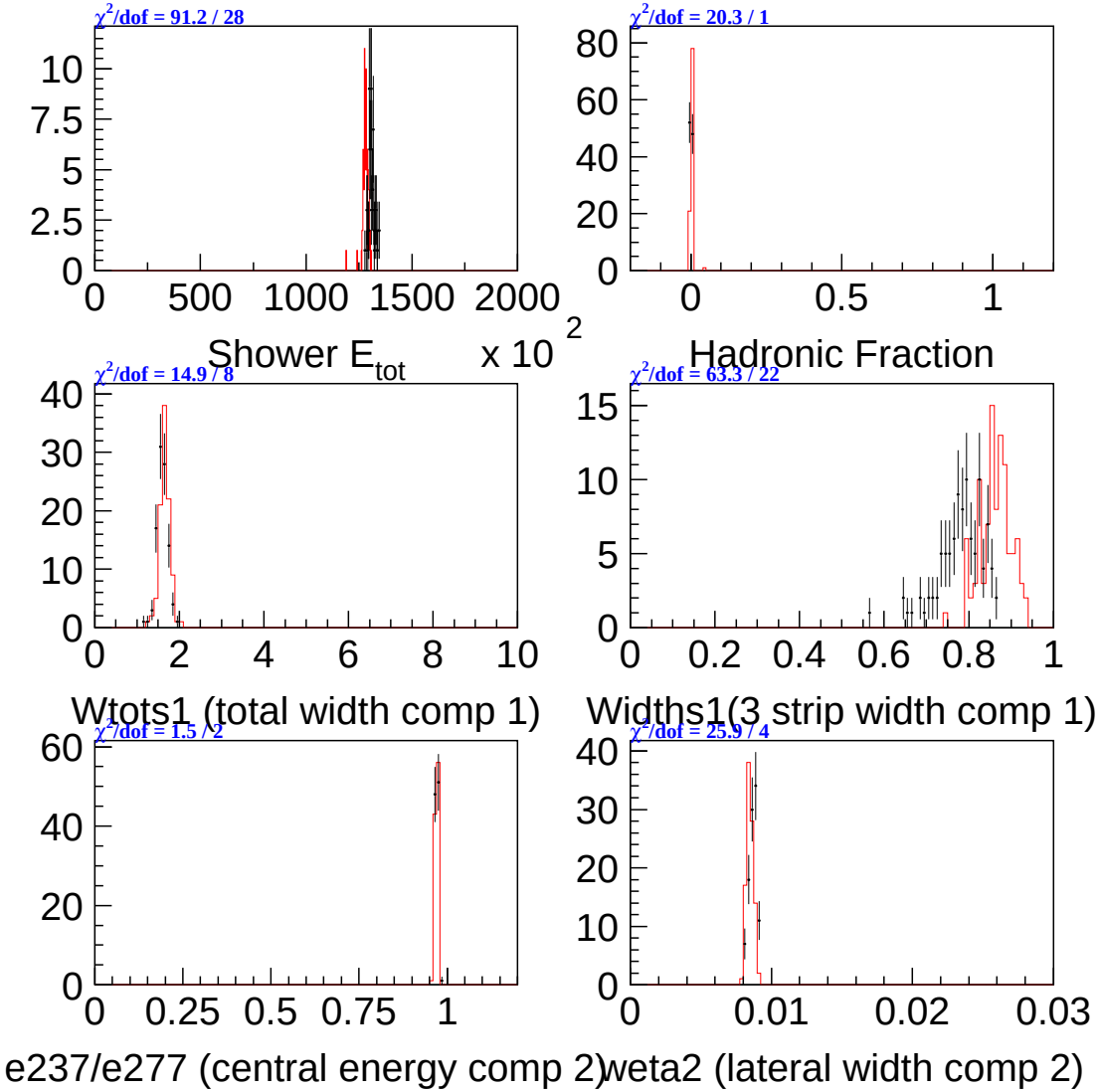
Validation: Bias in Total Energy



Significant bias for the parameterized LAr showers for rapidity $y = 1$, does not change with full simulation of low E electrons.

Might come from the transition region at $y = 0.8$. Needs to be checked!

Shower Shapes — full sim. of low E electrons

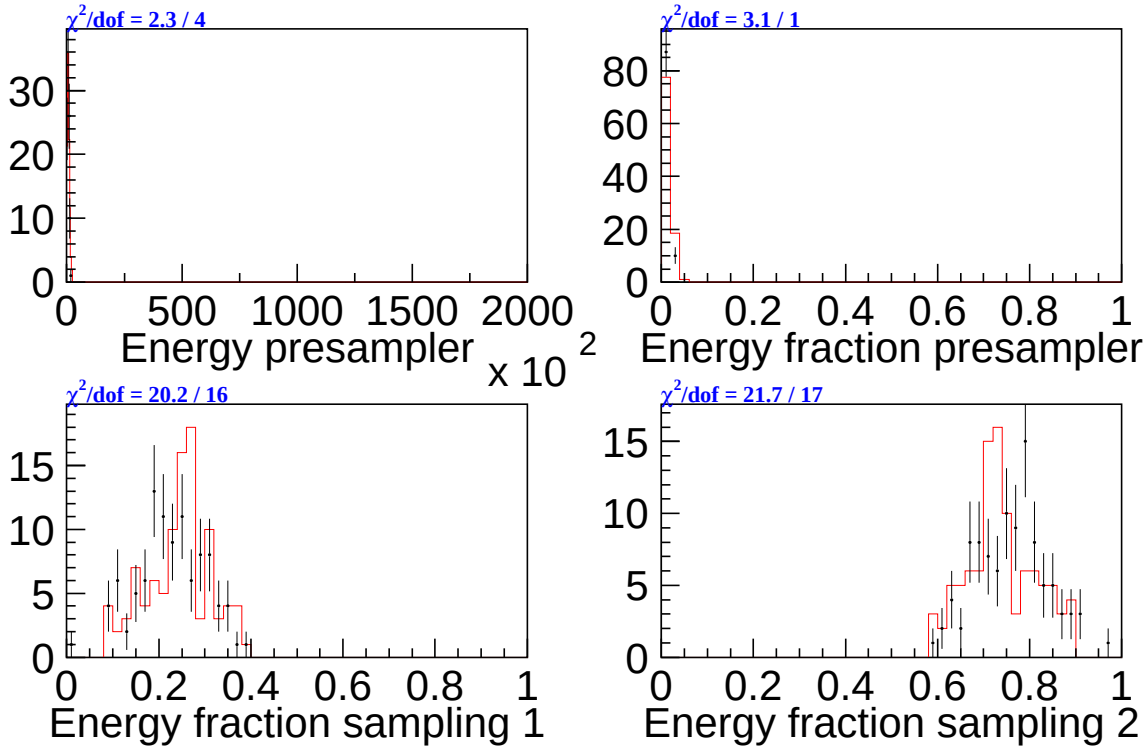


Comparison of the EMShower properties for parameterized showers (dots) and full simulation (histo) for $E_e = 128$ GeV and $y = 0.25$.

Good description of hadronic comp. leakage (none in both), good description of the total shower width in 1st EM compartment, but still poor for the core of the shower.

Similar level of agreement for other E_e, y test points.

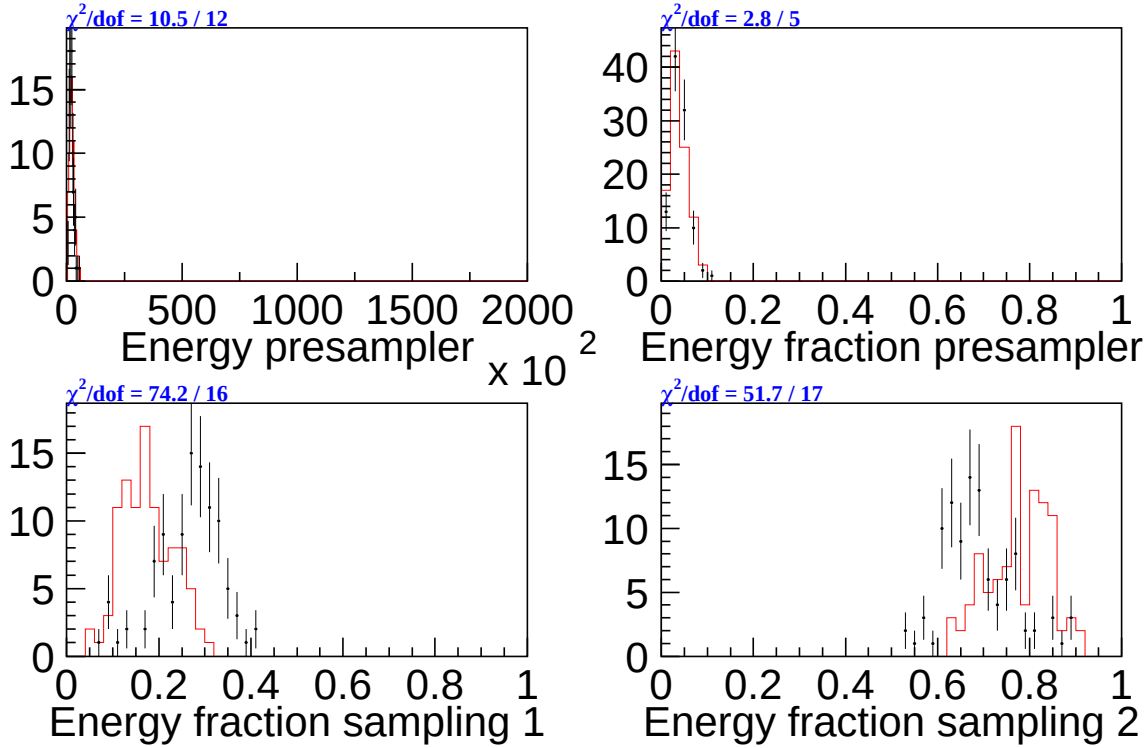
Check of Longitudinal Energy Distribution



Check fraction of energy deposited in preshower, 1st and 2nd compartments. For preshower, parameterization should agree with full simulation.

For central region, $y = 0.25$, parameterization agrees well with full simulation.

Check of Longitudinal Energy Distribution 2



For $y = 1$, significant difference btw parameterization and full simulation.

Parameterized showers (dots) and full simulation (histo)

Validation: conclusions

- fast parametrisation not too bad
- discrepancies at $y = 1$
  - → not really clear who is working on this
- full simulation of low energy electrons takes time
  - → some new work going on here in our task force
  - → unique contributoin from us

Low Energy Electrons

What to do with the low energy electrons (particles)?

- **fast parametrisation looks good between 1 and 100 GeV**
- **dumping energy in one spot for photons below 100 MeV does not work**
- **what to do for low energy electrons?**
  - **→ below 100 MeV kill them and dump in one spot**
    Is this okay for realistic shower description? No!
    What is a realistic cut off?
  - **→ up to 1 GeV to full simulation**
    this takes time!

→ 1. optimise kill cut off
(studies suggest a good cut off at 10 MeV)

→ 2. new idea for intermediate region
(shower library)

Ideas for low energy particles: Shower Library

Use shower library approach to simulate low energy electrons (& photons):

- **Separate simulation to record GEANT hits for particles simulated at calo surface. Store compressed information.**
- **In `FastShowerModel::ElectronDoIt` Get GEANT hits from a shower depository instead of shower parameterization. After that, follow the same steps (rotate, store Spots ...).**

→ shower shapes should be well described (full simualation)
→ timing should improve (stored information)
→ optimise storage, shower shape description and timing by using calorimterer geometry
(energy scaling, position translation, direction rotation)

Need to develope code to store/retrieve showers (athena service). Raising division threshold btw shower library/parameterization may help shower shape estimators.

Shower Library Implementation

`LArG4GenShowerLib`: **generation and storage of shower lib**

- → **data classes (hit, shower, energy bin, shower lib)**
- → **generate shower libary (collect hits)**
- → **writing of shower lib**

`LArG4ShowerLibSvc`: **interface for FastShowerModel**

- → **reading of shower lib**
- → **energy binning, translation, rotation, ...**
- → **returns list of GEANT hits to put into simulation**

`LArG45FastSimulation`: **do fast simulation**

- → **test for correct energy range and use shower lib**

Summary

- found problems in fast parametrisation
  - → overall agreement is okay
  - → $y = 1$ region is problematic
  - → low energy particles need work
- working on shower library implementation
  - → needs lot of infrastructure (service, IO)
  - → hope to have some preliminary results very soon
  - → might be extended up to full energy range
- got some new woman power: Ringaile