The ATLAS Fast Calorimeter Simulation FastCaloSim

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The FastCaloSim calorimeter simulation was developed to provide a reasonably realistic but still fast simulation of the ATLAS calorimeter system. Parametrizations of electromagnetic and hadronic calorimeter showers are used to deposit particle energies in the detailed calorimeter structure.

In order to evaluate the performance of FastCaloSim, the inner detector and the muon system are simulated with Geant 4. This combination of full and fast simulation is called Atlfast-II and reduces the overall simulation time by approximately one order of magnitude [1].

Calorimeter simulation model

- The simulation uses the reconstruction geometry of the calorimeter that describes calorimeter cells as cuboids in the r, η, φ space (forward calorimeter cells are cuboids in x,y,z)
- The fast simulation model reproduces the longitudinal shower properties, including fluctuations and correlations by parametrizations, but only average lateral shower properties and uncorrelated energy fluctuations.
- Only photons, electrons and charged pions are parametrized and used for the simulation. The charged pion parametrization is used for all hadrons (both neutral and charged).

Simulating performance

Distributions of CPU time for 250 tbar events in full Geant4 and Atlfast-II simulation

Note: “Fast G4 Sim” also utilizes parametrization to reduce CPU time but only for low energy particles.

Comparison of jet and missing transverse energy observables

The Atlfast-II performance for jet and missing transverse energy is compared to the full Geant4 detector simulation sample of non-diffractive minimum bias.

Charged hadron calorimeter response

The calorimeter response to charged hadrons is quantified computing the ratio between the energy E, deposited by a single isolated charged particle in the calorimeter, and the momentum p of the corresponding track. The E/p ratio is compared between Atlfast-II and the full Genat 4 detector simulation of non-diffractive minimum bias events generated with Pythia. They agree within the level of 10%.

<Ep> as a function of the track momentum, for 0 < η < 0.6 and p > 2 GeV.

Electron identification efficiency for medium electrons [2], with respect to truth electrons, as a function of η (left) and pseudo-rapidity (right).

References

[2] ATLAS Collaboration, Measurement of the W and Z → gamma* production cross sections in proton-proton collisions at √s = 7 TeV with the ATLAS detector