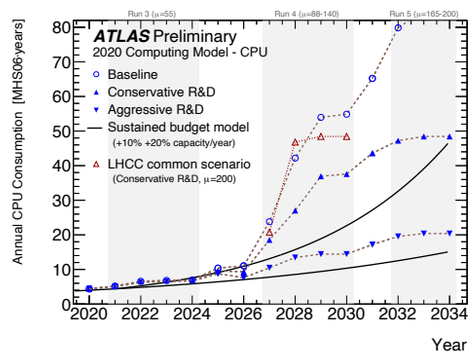
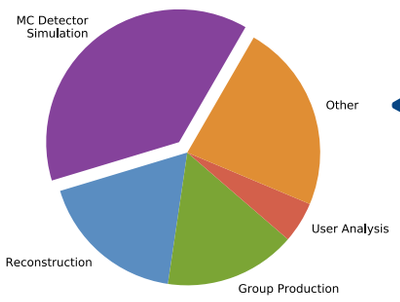
AtlFast3: The Next Generation of Fast Simulation in ATLAS

LHCC Poster session - CERN, November 18th 2021

Motivation

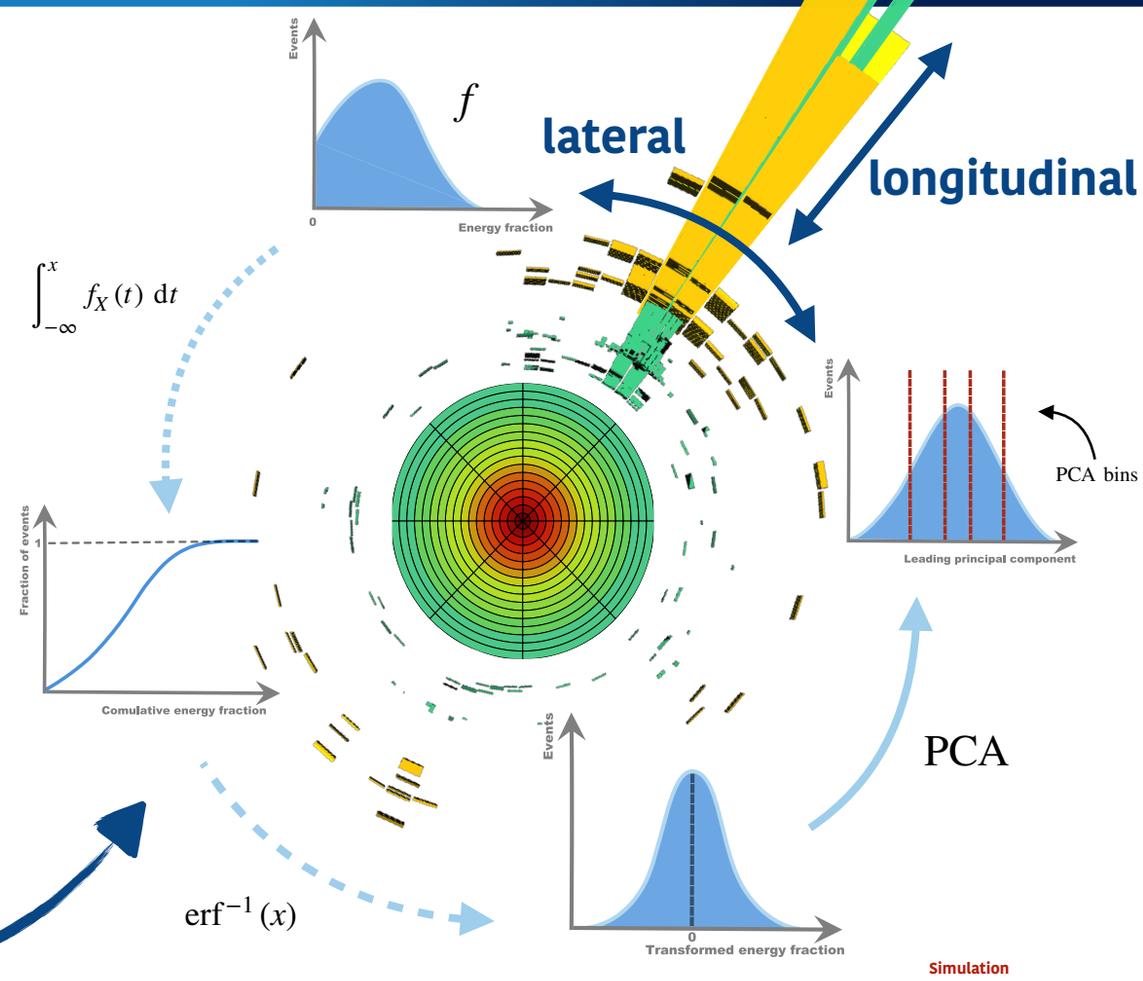
Significant R&D required to keep up with rising CPU needs for Run 3 and beyond





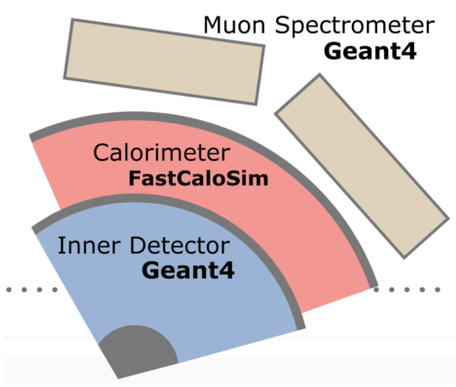
Most CPU consumption spent on MC detector simulation with **80-90% used for simulation of the calorimeter**

★ Previous fast simulation tool AFII limited in physics performance



Strategy

AtlFast3 consists of two distinct approaches of shower generation:

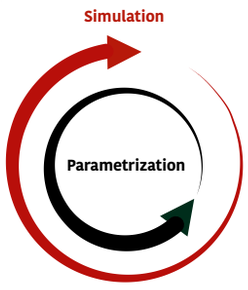


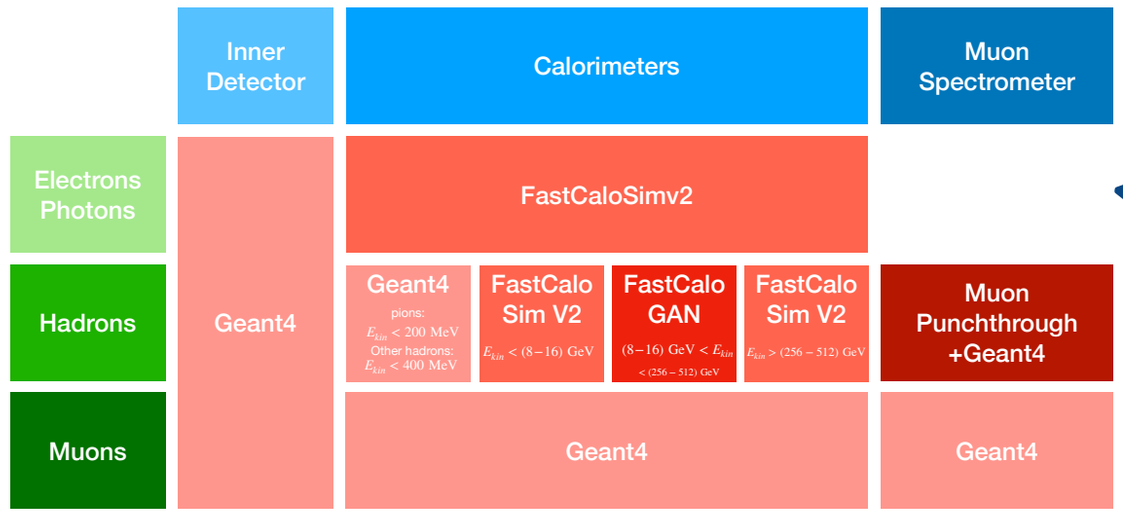
FastCaloSimV2

- Parametrised modelling using Geant4 single photon, electron and pion samples
- Parametrization in logarithmically spaced energy bins from 64 MeV to 4 TeV and linearly spaced bins in $|\eta|$ from 0 to 5
- Separate parametrisation of **longitudinal** and **lateral** shower development
- Energy deposits highly correlated between layers
- Decorrelate layers using **Principal Component Analysis** (PCA)
- Average lateral energy distribution parametrised as 2D probability functions

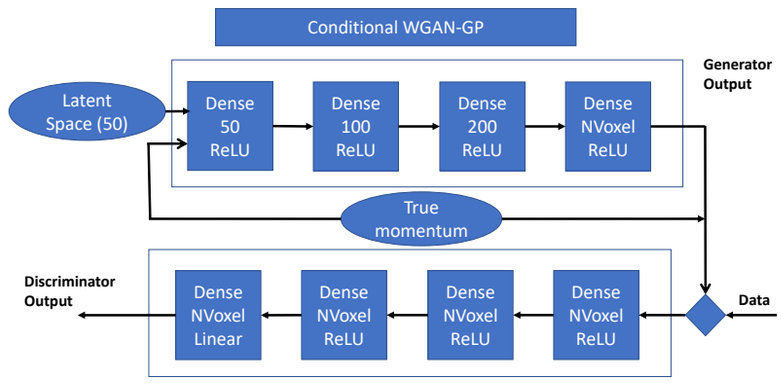
FastCaloGAN

- Wasserstein **Generative Adversarial Networks** (GANs) trained on each of the 100 bins in $|\eta|$ and conditioned on truth momentum
- Trained to reproduce voxels and energies in layers as well as total energy in single step
- Total of 300 GANs to cover full detector region
- Used for hadrons in the intermediate energy range

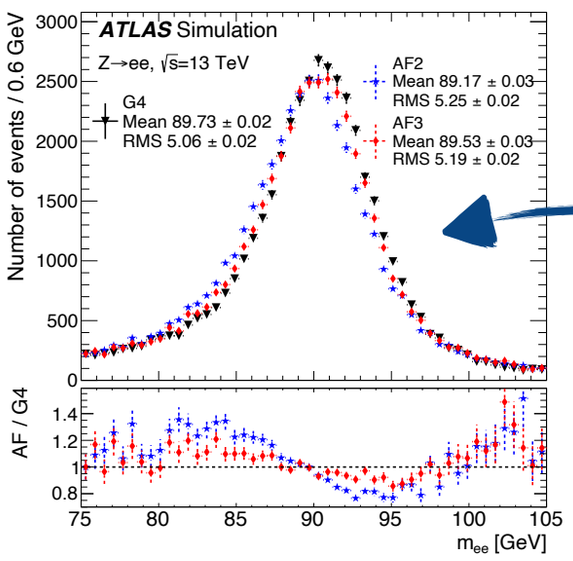




Simulator configuration

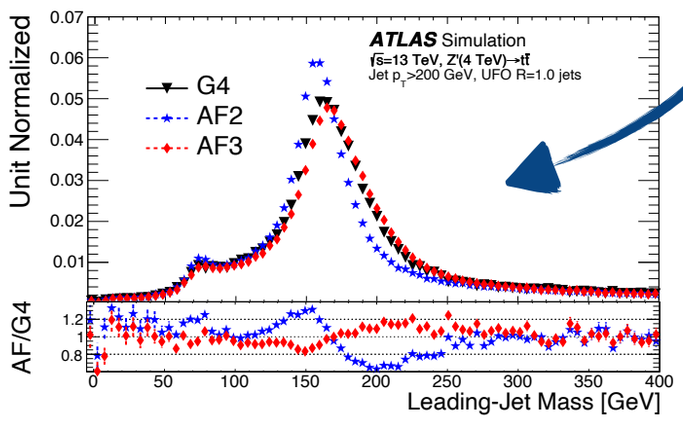


Results

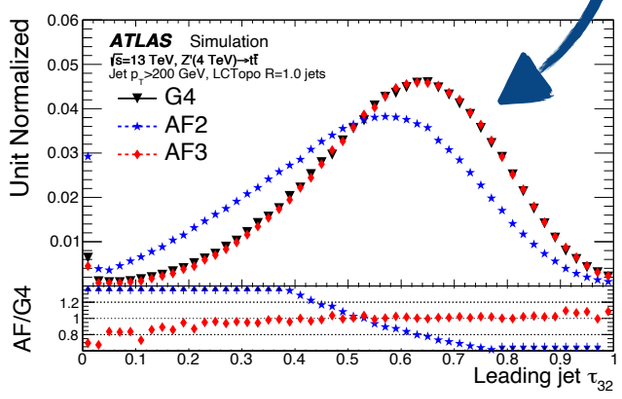


Reconstructed Z mass from $Z \to ee$ decays

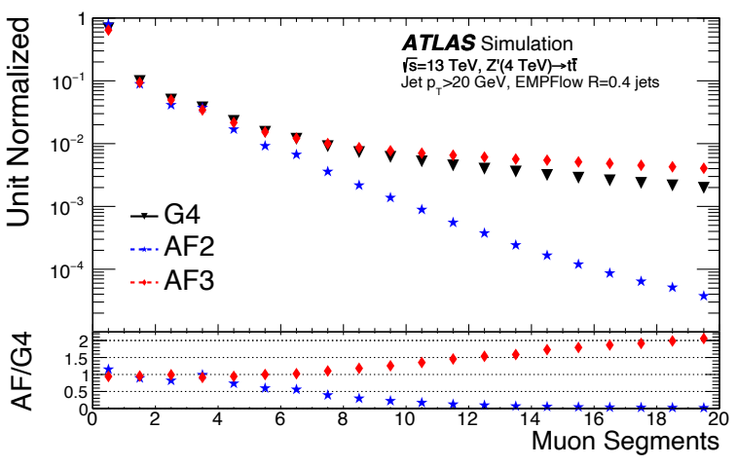
Leading jet mass in $Z' \to t\bar{t}$ decays

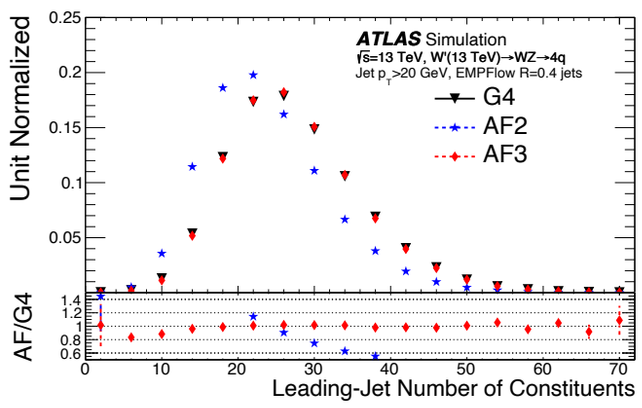


Leading jet τ_{32}



Associated muon segments in $Z' \to t\bar{t}$ decays





Leading jet number of constituents in $W' \to WZ$ decays

Conclusions

- AtlFast3 is the **state-of-the-art fast simulation in ATLAS** and able to simulate broad range of physics processes with high precision
- AtlFast3 provides **significant improvements in physics performance** compared to AF2
- AtlFast3 requires **80% less CPU time** compared to Geant4
- Simulation time in AtlFast3 completely dominated by full simulation of the Inner Detector

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SCAN ME!

Joshua Falco Beirer (CERN, University of Göttingen), **for the ATLAS collaboration**