Calorimeter & Tracking Simulation in Latest ATLAS Release

ATLAS Fast Track Trigger Meeting
Thursday, 30th September
Ambreesh Gupta
University of Chicago
DC2/Phase 1 Status/Resources (From DC2 Status Talk)

- Full G4 Simulation; 10 million physics events and several million calibration samples.
- Simulation done on three Grids
  - Grid3 (2800 cpu)
  - Nordu Grid (3280 cpu’s for ATLAS)
  - LCG (3800 cpu)
- 100K jobs submitted, 7.94 million events fully simulated, 30 TB.
- Next steps: Pileup, Tier-0 exercise - In parallel reco of all data. Need release 9.0.x.
G4ATLAS Summary: Andrea Dell`Acqua’s Talk

- Geant 4 a great success in ATLAS DC2. One known crash due to G4 itself.
- GeoModel used extensively.
Ongoing validation of MC truth

IDET “radiography” based on truth information (by F.Gianotti, Phys. Validation meeting 15/9/04)

Things seem to work!

From Dell’Acqua’s Talk
Digitization and Pile-up: Davide Costanzo

- PileUp functionality available and working since 8.0.6.
  - works in 8.7.0. No major functionality change.
- Memory leak related issues solved.
MC Truth (The Digitization part)

HepMcParticleLink assumes to have a collection named G4Truth

Filled by G4Atlas

32 bits
Ext. Barcode

16 bits
Evt Idx

HepMcParticleLink: pointer semantics
*PL is a GenParticle

Index refers to PileUpEventInfo

Pile-up Digitization:
- Read the hits from Pool and create a TimedHitPtrCollection<Hit>
- TimedHitPtr contains HIT, adds Bunch xing time, Event Index
- No link b/w RDO and Simulation Data Objects. Mapping with Identifier

Simulation Data Object:
- Non IDet specific. Common for Tracking?
- One InDetSimData per candidate RDO
- std::pair<Identifier,Deposit>
- Deposit is a std::vector<energy (float), HepMcParticleLink>
- ~3times as big as RDOs. Big overhead for Pile-up…
- Maybe Heavy, but it’s for Truth debugging only
Inner Detector (Thomas Kittelmann’s Talk)

_migration to Oracle DD Database for primary numbers
- SCT and TRT fully integrated

Initial Layout
- Inner layer of Pixel and TRT will be missing.
- Possibility for construction of initial layout in simulation implemented, with easy switching between jobOptions.

Full PileUp implemented for Pixel and SCT. PileUp for one bunch crossing available for TRT. Work on multiple crossing ongoing.

SCT Barrel resolution - tuned with 2002-03 TB data. This has led to improvement in resolution from DC1/G3.
SCT Barrel Resolution

From ID talk
LAr Calorimeter (Joe Bouderau’s Talk)

Next four slides from his talk
- simulation for physics
- detector description
- cpu issues
- shower parametrisation
Z mass and Higgs Mass. Thanks to Kyle Kranmer (UW), Davide, Ketevi.

Using: Simulation 8.0.5 and Reconstruction 8.6.0; analyzed from AOD.

\[ H \to 4e \ Analysis \]

We see the impact of electron resolution on \( M_{12} \) and \( M_H \)

\[ M_Z \] reconstructed at 86 GeV
(No Z-mass constraint here)
- Some simple visual checks of the simulation can also be performed.
- Note, such simple checks would have found a 180° rotation in tilecal!
- What is shown in this picture is simulation-level hits.
Detector Description: A full geomodel version of the LAr calorimeter is available. Memory cost of this seems minimal; e.g:

* LAr Barrel 150 kBytes nonsagging
* LAr Barrel 10 Meg when it sags... expected to be similar to nonsagging barrel when we are done.

* Other pieces should be similarly small.

* Now AFTER 9.0.x we will connect this to the simulation.

Barrel: Guilluame Unal
Barrel Presampler: Driss Benchekroun
Endcap: Joszef Toth
HEC: Pavol Strizenec
FCAL: Peter Loch
Cryostats: Misha Lelchuk
CPU issues.

* H→e+e−e−e+: ~ 30 minutes on Joe’s laptop.

* Speeding up the simulation of the calorimeter to enable desktop thought experiments would have a major impact on the ability of ATLAS to harness the creativity of its participants.

* Task lies squarely with the calorimeter simulation teams.

* Fast shower parameterization is the work of:

  Arno Straessner  
  Elisabetta Barberio

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η < 0.8

plots in 2 pages...
We put a lot of effort in parameterising the radial shape properly.

\[
t/T_{\text{max}} = [0.2, 0.4]
\]

\[
t/T_{\text{max}} = [1, 1.2]
\]

\[
t/T_{\text{max}} = [2.4, 2.6]
\]

• find a function that describes the complete shower and radial tails

\[
\langle \frac{1}{dE(t)} \frac{dE(r,t)}{dr} \rangle = pg_1(r) + (1 - p)g_2(r)
\]

\[
g_i(r) = \frac{1}{2\lambda} \left( \frac{r}{\lambda} \right)^{\alpha/2 - 1} e^{-\sqrt{r/\lambda}} \frac{1}{\Gamma(\alpha)}; \quad \lambda = \lambda(\tau); \quad \alpha = \alpha(\tau)
\]
Calibration hits: ... coming for version 9.0.x... special run option, only. Lots of work here from Bill, Misha, Margret, Peter, Guillaume, Leonardo. ..entire community.

* Idea is to do a careful accounting of where the energy goes in ATLAS.
  
  * electromagnetic energy.
  * hadronic energy.
  * invisible energy (absorption of particles)
  * escaped energy ($\mu, \nu$)

* Reason:

  * better understanding of the detector.
  * determine calibration constants from Monte Carlo on a cell-by-cell basis, for EM &Had processes. (Leakage, upstream matter, sampling fraction.

* Implies:

  * sensitive regions must record all 4 energies.
  * dead regions must be rendered sensitive.
  * non-LAr materials will be attached to a default sens. detector that records energy flow and accumulates the four energies in voxels.
Tile Calorimeter (Anna Lupi’s Talk)

Next five slides from her talk on TileCal simulation status
Status of Tile Simulation Tools
Release 9.0.0

• Full ATLAS initial layout ready and DC2 compatible (V.Tsulaia)
  – Special JobOptions to disable two crack scintillators
    • E3, E4 in between LAr cryostat will not be installed
  – Two parallel and equivalent descriptions for Tile geometry can be used:
    Hand-coded G4 and GeoModel
  – Simulation with geometry translated from Geomodel has been tested
    – it works
    – same results as hand-coded G4 geometry
      » more validation would be nice…
Tile Simulation Results

- **DC2: digitization is just starting**
  - Bug in geometry was fixed for 8.0.4 DC2 release in June (Vakho and Sasha)
    - Modules were rotated by 180 degrees
      - Bug found looking at single pions event (see plots)

- **First look at simulated data for CTB** (V. Giangiobbe)
  - Work is going on
    - First results are available: we are verifying all calibration factors involved
      - $p_{\text{Cb}}$/GeV value at the test beam
      - Sampling fraction in simulation
50 GeV pions $\eta=0.2$ in TileCal

**Real DATA**

Release 8.7.0

RecExTB-00-00-41

**Simulation**

Release 8.7.0

CTB_G4Sim-00-02-03

RecExTB-00-00-41
Simulated Pions in Lar+Tile

- **Eta in LAr**
  - Ent. 1333
  - Mean -0.9214
  - RMS 0.2284

- **Phi in LAr**
  - Ent. 1333
  - Mean 0.9730
  - RMS 0.5170

- **Eta in Tile**
  - Ent. 20
  - Mean -0.916
  - RMS 0.2603

- **Phi in Tile**
  - Ent. 20
  - Mean 0.9440
  - RMS 0.1015
Work in 9.x.0 – 10.0.0 release cycle

• Non-symmetric geometry of TileCal
  – All special modules, missing fingers, etc. described in new Oracle DetDescr database and loaded to Geant4 on request
    • i.e. comparison of ideal/real geometry for Rome

• Calibration Hits
  – Calibration production for CTB04 and comparison with real data (preliminary results for Calibration Workshop in December)
  – Validation of Tile+LAr calibration software for ATLAS geometry setup
    • Special validation with calibration hits
    • Study of various weighting algorithm
      (preliminary results for Rome)
Trigger Simulation (From Alan Watson)

- There is a container package \(~\text{offline/Trigger/Trig1}\) with all the Level 1 trigger software.
- Level 1 Calorimeter simulation in TrigT1Calo package
  - LAr/Tile/CaloCell (em/tau, jet, EtMiss, EtSum triggers)
    → Hits and RoI’s
- Loading of Trigger Menu done by TrigT1Config and LVL1 CTP by TrigT1CTP.
- Can configure menus and threshold using xml files.
- Also available Muon Level1 trigger, more complicated, 8 packages.
- \(~\text{offline/Trigger}\) container contains other Trigger related packages.