Muon Detection Based on a Hadronic Calorimeter

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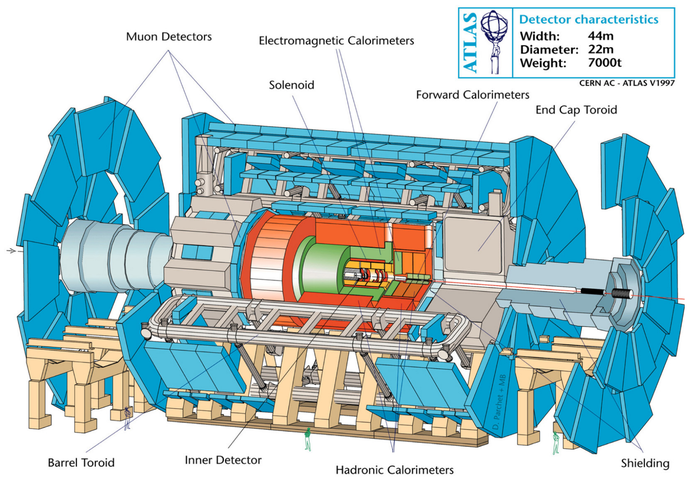
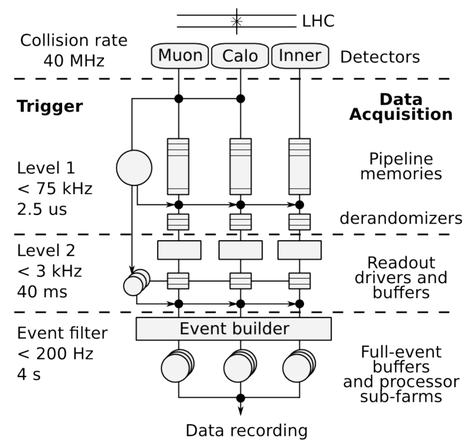
The ATLAS Detector

- At the Large Hadron Collider
- Proton-proton collisions up to 14 TeV at the center of mass
- Search for new physics
  - Higgs boson, supersymmetry...
- Produces over 60 TB of data per second
- Subsystems
  - Inner detectors, calorimeters, muon spectrometer





- The on-line trigger system
  - Selection of interesting events
  - 3 cascaded levels
  - Event rate and latency time
  - First level (L1)
    - Compact information
    - Calorimetry and muon chambers

L1 Muon Detection in the Barrel Region

- RPC: resistive plate chamber
- Used in 2009-2010 data taking
- Momentum estimation
  - Muon classification using 6 momentum thresholds
- 64 Trigger Sectors: several Regions of Interest (RoI)
- TileCal muon signal: from cells in the last calorimeter layer (D cells)
- **Upgrade: TileMuon receiver**
  - Trigger on muons using TileCal muon signal. Low signal-to-noise ratio
  - Combine RPC and TileCal triggers
  - **Goal:** reduce unforeseen high trigger rate due to cavern background
    - Might also be used to recover RPC's inefficiency regions
  - What is the impact on muon detection?

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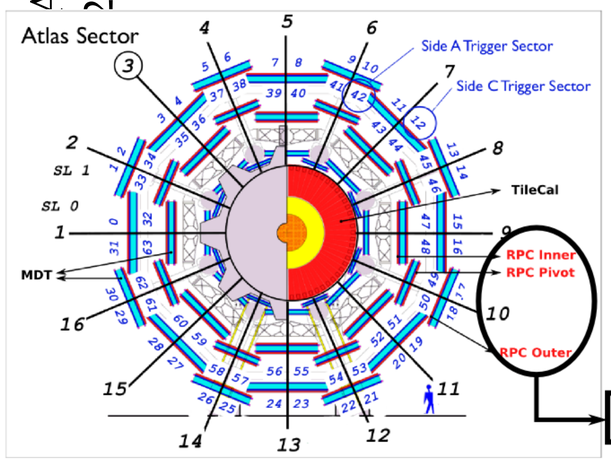
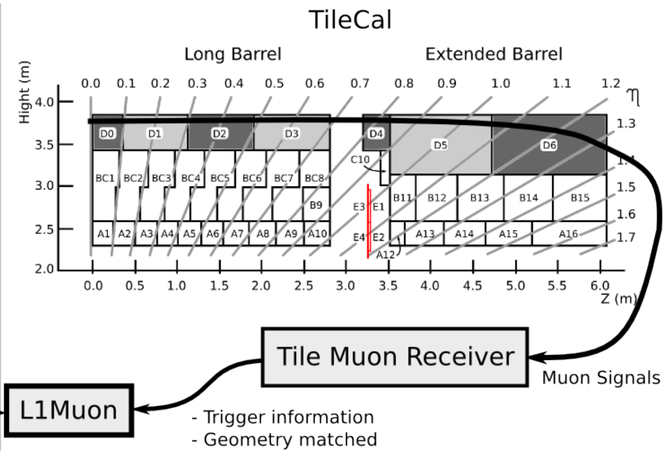
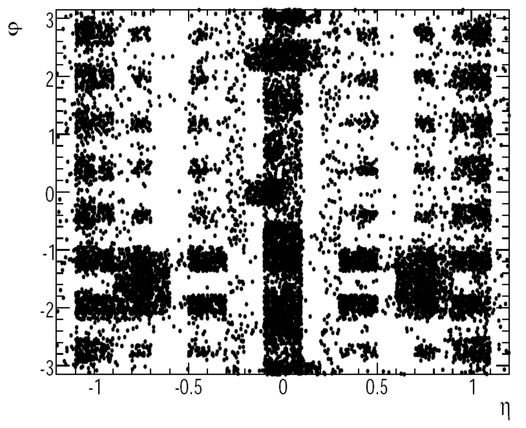




Geometry Matching

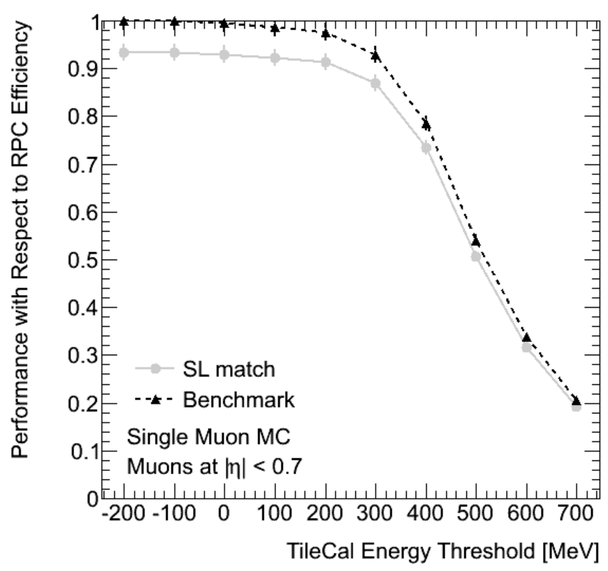
- Hard to match TileCal D cell and RPC RoI
  - Muon bending between TileCal and RPC
  - Incompatible sizes between cell and RoI
- Sector Logic (SL) matching (several RoI)
  - D cells mapped onto SL
  - SL triggered: at least one cell and one RoI
- RPC acceptance
  - ~80 % due to mechanical reasons
- Not using TileCal extended barrel
  - Little coverage over RPC range
  - For $|\eta| > 0.7$, RPC triggers with no confirmation from TileCal



L1 geometrical acceptance in the η-Φ plane, extracted from ATL-PHYS-PUB-2009-030

Preliminary Results on Single Muon Detection

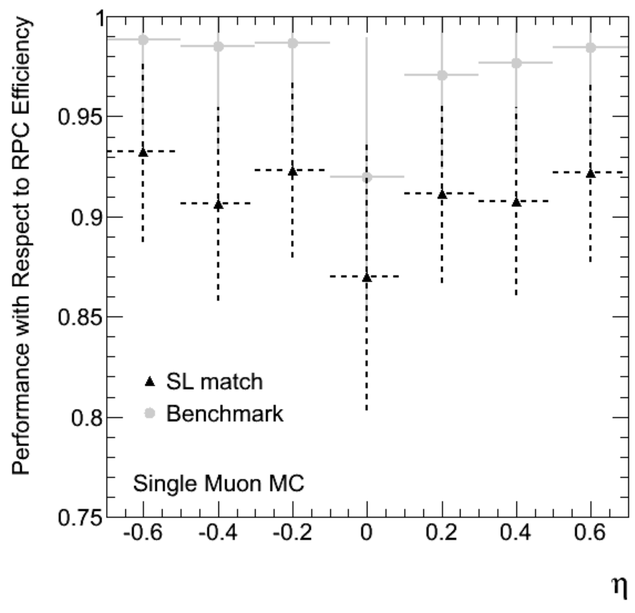
Combined muon trigger efficiency with respect to RPC trigger as a function of the TileCal energy cut applied



- Around 6.5 % inefficiency due to Sector Logic matching
- Plateau ends ~200 MeV for TileCal energy cuts
- Noise energy distribution
  - Energy threshold depends on D cell RMS
    - 3 σ around 75 MeV

- TileCal energy threshold must be tuned according to the D cell position in η
  - Muon energy distribution is η dependent
  - Low performance around η = 0.0 is due to the energy cut applied

Combined performance as function of the D cell η position, with a TileCal energy threshold of 200 MeV for all D cells. The results Are for the Sector Logic matching and the extrapolated track matching (Benchmark)



Monte Carlo Simulation Studies

- RPC trigger: 6 thresholds (MU0, MU6, MU10, MU0_COMM, MU15 and MU20)
- TileCal trigger: cuts on energy in D cells
- Performance: fully simulated (Monte Carlo) single muons
  - Muons with momentum of 40 GeV/c
  - Offline track extrapolation
    - Exact matching between RPC RoI and TileCal D cell (benchmark)

Conclusions

- Adding TileCal confirmation to RPC does not reduce the efficiency significantly: ~6.5 % inefficiency is due to the SL matching
- TileCal energy threshold must be tuned for each calorimeter D cell

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