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

The ATLAS Detector

- 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 |η| > 0.7, RPC triggers with no confirmation from TileCal

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

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?

Geometry Matching

- 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

Preliminary Results on Single Muon Detection

- 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

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)