

PARALLELIZATION OF ATLAS MUON TRIGGER ALGORITHM

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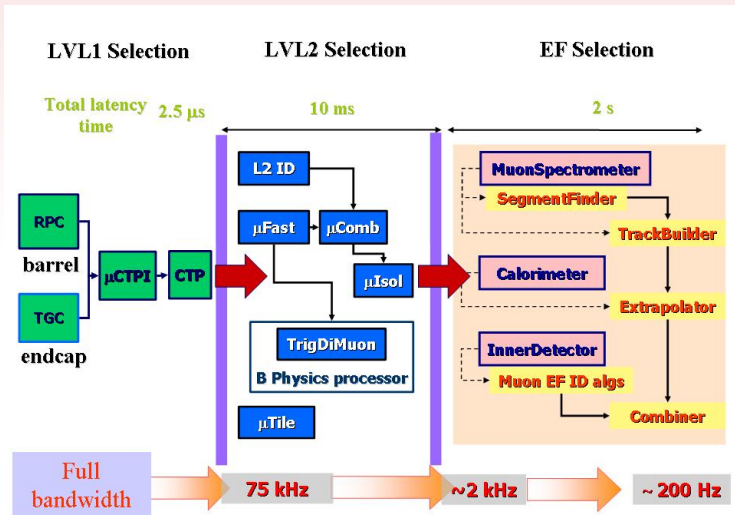
January 12, 2014



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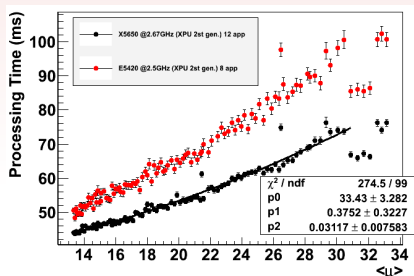


- ▶ Three stage trigger system to record data from 40 MHz pp interactions:
 - **L1 trigger** is completely hardware based, partial detector information used, reduce data rate to 75 kHz
 - **L2 trigger** is software based, exploits almost complete event information to reduce the rate to 3.5 kHz
 - **Event Filter** analyses the full event information giving an output rate of ~ 200 Hz
- ▶ Software Trigger Case Study (L2/EF): **Muon Reconstruction Trigger Algorithms**
 - Parallelization of three main trigger algorithms: muComb, muIso, muGirl
 - Investigate the improvements from parallel computation, in particular related to the expected high-luminosity regime
 - Study the possible improvements in the parameter resolution determination, to increase efficiency/purity of the event selections



- ▶ Starting from next run L2 and EF will be merged in a High Level Trigger (HLT), combining various algorithms.

- Level 2 Muon identification:
 - ▶ track reconstruction in the muon spectrometer: ~ 2.5 ms
 - ▶ combination with a tracks from ID: < 3 ms
 - ▶ track isolation in a given cone based on tracks and calorimetry: ~ 10 ms
- For track and energy reconstruction:
 - ▶ Algorithm execution time grows linearly with the pileup
 - ▶ Purity dependent on the width of the cone



- ▶ **Find the tasks that are naturally parallelizable,**
aim to a stable behaviour as pileup increase.

► Current implementation

- candidate reconstructed by SA-Muon as seed, extrapolation to IP using Look-Up Tables
- combine with a track in the Inner Detector: retrieve p_T, η, ϕ
- constraint on using loose matching criteria lead to 10% fake rates

Improvements from parallelization

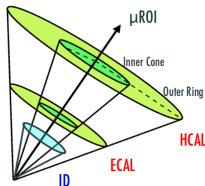
- Natural parallelization of the muon-track matching (pileup-dependent critical issue)
 - Additional tracks to consider from FTK detector
- Can implement a fast and precise Geant4 based extrapolation, that improves the LUT method

► Current implementation

- muon as seed (muFast, muComb)
- Track-based isolation: exploits tracks from the silicon inner detector, discriminates based on $\sum p_T / p_T^\mu$ in $\Delta R < 0.2$ cone
- Calorimeter-based isolation: evaluate the energy deposit in a cone with $\Delta R_{outer} < 0.4$ (EM+HAD), then discriminate based on $\sum E_T(outer) - \sum E_T(inner)$
 - muon energy loss subtracted through the calorimeter using a back-extrapolation of the trajectory

Improvements from parallelization

- Parallel processing of **full scan** information from FTK:
 - improves track isolation
 - pileup-dependent corrections to reconstructed parameters (already in offline)

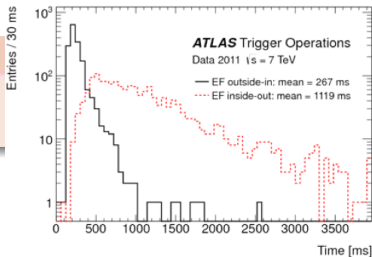


► Inside-out tracking algorithm, called `muGirl`:

- NN-based identification of muon candidate starting from an ID track, look for a segment match in the muon spectrometer
- Better efficiency than an outside-in algorithm in reconstruction of low- p_T muons (not crossing all of the spectrometer): interesting for B -physics analysis.

Possible improvements

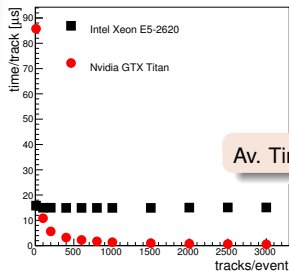
- NN implementation on GPU provide huge speedup factors



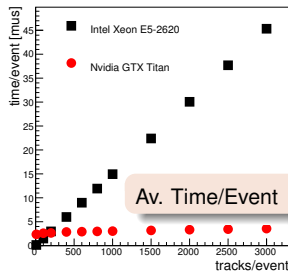
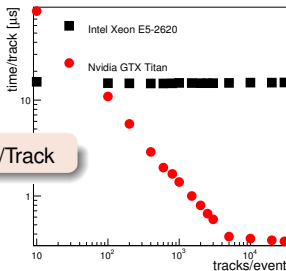
- Currently working for trigger algorithm parallelization
- Extract from the Atlas framework a standalone version from test (then include in the framework using the APE server)

► Track fitting on GPU - first test on the GAP server in Rome:

- Input: raw track candidates from Inner Detector RoI
- **Parallel fit of an increase number of track**



Av. Time/Track



Av. Time/Event

- GPU implementation less dependent on the track multiplicity:
 - promising for upcoming data taking conditions, with increased luminosity.