Commissioning of real time algorithms in the ATLAS tau trigger system

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The ATLAS tau trigger system uses sophisticated algorithms and is designed to select hadronically decaying tau leptons. The Level 1 trigger (L1) is hardware based and selects clusters for later processing in software based higher lever triggers, Level 2 (L2) and Event Filter (EF). At L2 fast and specialized algorithms and at EF detailed reconstruction algorithms are used. In this contribution we focus on the performance of L1, L2 and EF triggers during data taking period 2009 and 2010. We present our current results for 900GeV and 7TeV collisions data and the comparison with MC. Good agreement between data and MC observed in our results indicates the understanding of the performance and the robustness of the trigger system.

The ATLAS trigger is designed as a 3-level system:

LHC bunch crossing rate: 40 MHz

L1 mean processing time: $\sim 2.5 \mu s$

Level 1: Hardware based trigger, identifies geometrical "Regions of Interest" (RoI) for higher level systems

L1 output rate: 75 kHz

L2 mean processing time : $\sim 40 ms$

Level2: Software based trigger, analyses full granularity data inside the RoI seeded by L1, using partial event readout, and without noise suppression.

EF mean processing time: $\sim 4s$

Event Filter (EF): Remaining events are analyzed using offline algorithms at the EF level, with the full event read out if needed.

Level 1 tau trigger: Hardware trigger is using the electromagnetic and hadronic calorimeter trigger towers $\Delta\eta \times \Delta\phi = 0.1 \times 0.1$. It identifies taus based on the following features:

- energy in 2×1 pairs of EM towers
- energy in 2×2 hadronic towers behind EM clusters
- EM isolation in 0.1 wide ring
- Had isolation in 0.1 wide ring

L1 identifies the local cluster maximum and performs selection by applying cuts on cluster. In the bottom left plot is the cumulative L1 tau trigger rate as a function of L1 tau object E_T threshold. Plot on right shows L1 tau trigger turn-on curve for data from 7TeV collisions and minimum bias MC.

HLT output rate: 200 Hz

One of the most significant backgrounds to the search for hadronically decaying taus is the QCD background. To distinguish taus from jets the typical nature of taus is being used: **low track multiplicity, isolation and narrowness.**

HLT Level 2:

The characteristics of hadronic tau decays is used: low charged track multiplicity, isolation, and narrowness. Additionally, the E_T in a narrow cone $\Delta R < 0.1$ is proven to have a good rejection power for the background. The distribution for L2 E_T is shown on the plot at the right. Plot at the left shows the track multiplicity of L2 tau candidate.

The difference in track multiplicity between L2 and EF shown below is due to different cuts applied on P_T of the tracks, which is 1.5GeV at L2 and 1GeV at EF. On both plots we can observe very good agreement between MC and data.

HLT EF:

The EF tau candidate is reconstructed using L1 tau object as seed and using the same reconstruction algorithms as in offline data processing. EF tau candidates provide a wide range of identification variables, refined with respect to L2. On the upper plot is the EF EM radius which is an energy weighted ΔR of the calorimetric cells associated with the tau trigger candidate around the EF position. On the bottom plot is the track multiplicity of the tau trigger candidate.

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ATLAS EXPERIMENT

2010-03-30, 13:16 CEST
Run 152166, Event 399473

2-Jet Collision Event at 7 TeV

<http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html>

On the picture above is a dijet event from 7TeV collisions as seen in ATLAS event display. Jets from these kind of events can be a potential background to hadronically decaying taus.