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The performance of the ATLAS tau trigger in 8 TeV collisions and novel upgrade developments for 14TeV

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The LHC is the world's highest energy and luminosity proton-proton (p-p) collider. During 2012 luminosities neared 10^34 cm-2 s-1, with bunch crossings occurring every 50 ns. The online event selection system of the ATLAS detector must reduce the event recording rate to only a few hundred Hz and, at the same time, selecting events considered interesting. This presentation will specifically cover the online selection of events with tau leptons decaying to hadronic final states. The "hadronic tau trigger" has been operated successfully since 2009. Tau leptons provide a unique window for understanding physics at the Tera scale. They are the most crucial signature for measuring the fermion couplings of the Higgs boson, an important next step in identifying the recently discovered Higgs-like boson. Many theories also predict new particles beyond the Standard Model that have large couplings to tau leptons. The first step in their identification is the online event trigger.

ATLAS employs a 3-level trigger scheme. The level-1 (L1) hadronic tau trigger system measures energy deposited in electromagnetic (EM) and hadronic (HAD) calorimeter trigger towers to select taus based on energy in core and isolation regions. The remaining two levels, are software-based. At the second level, further identification is done within regions of interest identified by L1, taking into account track and calorimeter information with dedicated fast algorithms. At the third and final level, the event filter algorithms closely match the algorithms used for offline reconstruction. Taus are often mimicked by similarly behaved quark jets, which have large rates. The rate at which events must be selected severely limits the complexity of reconstruction algorithms, compounded by the high probability of overlap (pileup) between bunch crossings. ATLAS has a program dedicated to the continued improvement of the tau trigger to address these problems, including: Multivariate identification algorithms using high granularity calorimeter and tracking information, fast track reconstruction methods for accurate determination of impact parameters reducing pile up, and new topological criteria using multiple event features. The latter involves simultaneous triggering on taus with muons, electrons, and missing energy. These developments have given ATLAS the potential to explore a large program of tau physics analysis.

This presentation gives a full overview of the ATLAS tau trigger system, summarising the running experience over the past 3 years. We demonstrate that the ATLAS tau trigger performed remarkably well throughout its operation, and discuss computational innovations in 2012. Results of the performance of the tau trigger from the full 22 fb-1 2012 p-p data taking period will be shown, including measurements of the trigger efficiency using Z->tau tau and W->tau nu events and the application to searches for tau tau resonances, such as the Higgs boson. We also outline the upgrade plan to 2015 for 14(13) TeV LHC proton-proton collisions, which includes the use of a novel associative memory trigger for track finding throughout the full detector.

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