IMPLEMENTATION AND PERFORMANCE OF THE TAU TRIGGER IN THE ATLAS EXPERIMENT*

M. Bosman[a], P. Casado[a], M. Dam[b], S. Demers[c], O. Igonkina[d]
C. Osuna[a], E. Perez[a], R. Soluk[e], D. Strom[d], E. Torrence[d]
A. Watson[f], S. Xella[b]

[a]Institut de Física d'Altes Energies (IFAE), 08193 Bellaterra (Barcelona), Spain
[b]Niels Bohr Institute, University of Copenhagen
Blegdamsvej 17, 2100 Copenhagen, Denmark
[c]Stanford Linear Accelerator Center (SLAC)
2575 Sand Hill Road, Menlo Park, CA 94025
[d]University of Oregon, Eugene OR 97403, USA
[e]University of Alberta, Edmonton, Alberta T6G 2R3, Canada
[f]School of Physics and Astronomy, Edgbaston, Birmingham B15 2TT, UK

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This note presents the ATLAS trigger for taus, which is a challenging task in the LHC enviroment with its hard limitations on event processing time and rate of the output events which can be recorded.

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1. Introduction

Possibility of identifying and triggering taus will be very important in many searches for new physics at the LHC, like the SM and beyond SM Higgs, and in a significant part of the SUSY parameter space. Some examples are VBF $H \to \tau\tau$ that plays an important role in the discovery of the SM Higgs, Charged Higgs for which the $H^{\pm} \to \tau\nu$ is the dominant channel at high $\tan\beta$, or SUSY decay chain with a large component of taus in the final decay products. The possibility of triggering on hadronic decays of taus will improve the acceptance and the discovery potential.

The ATLAS detector [1], within the Large Hadron Collider experiment is expected to start data taking in 2008 at CERN (European Organization for Nuclear Research). LHC will provide proton–proton collisions with a bunch

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crossing rate of 40 MHz, at a center of mass energy of 14 TeV and design luminosity of $10^{34}\text{cm}^{-2}\text{s}^{-1}$. The affordable output trigger rate for ATLAS is around 200 Hz, meaning an overall trigger rejection of 2×10^5 is needed.

Tau trigger is one of the several components of the ATLAS trigger system used standalone to collect high p_{T} taus as well as in combination with other signatures like e, μ, jet or missing E_{T}.

2. The ATLAS tau trigger

The ATLAS trigger system is organized in three levels. The first level [2] has the task to reduce collision rate of 40 MHz to 75 kHz and has to take a decision in 2.5 μs. It is hardware, calorimeter based system with granularity of 0.1 $\times$ 0.1 in η/ϕ. For each *cluster* of energy deposition in the calorimeter it defines a "Region of Interest" (RoI) around it which will be passed to the next trigger level.

The second and third trigger levels [3] (Level2 and Event Filter, respectively) are software based, and analyze calorimeter and tracking data only within the RoI provided by the Level1 in order to speed up the decision. They are able to perform a more refine event reconstruction and reduce the rate to less than 200 Hz. The decision average time must be of 2 ms for Level2 and 0.2 s for Event Filter.

An example of the rejection power of the HLT variables is shown in Fig. 1.

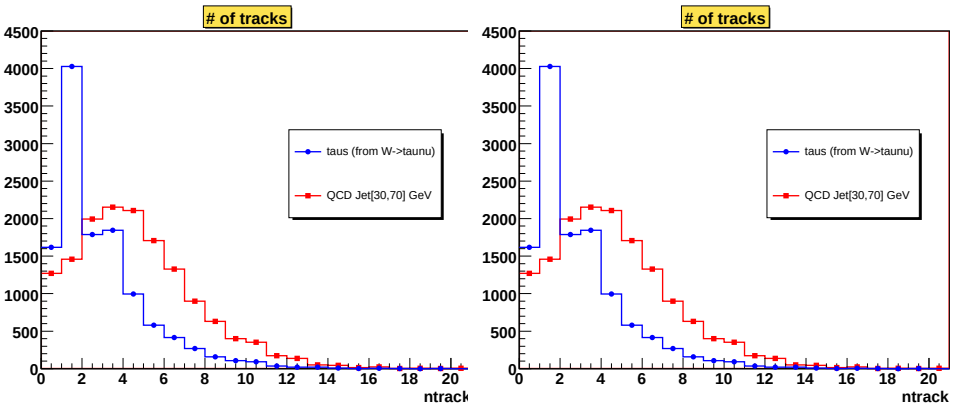

Fig. 1. Left: number of tracks found within the RoI, for taus (blue) and jets (red). Right: Width of calorimeter cluster in eta, for taus (blue) and jets (red).

Various candidate tau trigger menus items are under study. Proposed menus with the physics goals for different luminosities and expected number of events of reference samples are shown in Table I.

TABLE I

Several tau menus in combination with electron, muon, jets, b-jet and missing Et signatures.

Signature	Physics goal at 10^{31}	Physics goal at 10^{33}	#ev(100pb^{-1}) for $W \to \tau\nu$	#ev(100pb^{-1}) for $Z \to \tau\tau$
Tau55i	$W \to \tau\nu$	High pt physics	32×10^3	4.6×10^3
Tau10i+El10i	$Z \to \tau\tau$,SUSY	$H \to \tau\tau$,$Z \to \tau\tau$,SUSY	100	1.5×10^3
Tau15i+MET30	$W \to \tau\nu$,$t\bar{t}$	$W \to \tau\nu$,$t\bar{t}$,SUSY	50×10^3	3×10^3
Tau+Jets	SUSY,$t\bar{t}$	VBF Higgs,SUSY,$t\bar{t}$	—	—
Tau15i+b18	$t\bar{t}$	$t\bar{t}$	—	—
Tau10i+tau15i	$Z \to \tau\tau$,SUSY	$H \to \tau\tau$,$Z \to \tau\tau$,SUSY	4×10^3	4×10^3

REFERENCES

[1] ATLAS Collaboration, ATLAS Detector and Physics Performance Technical Design Report, CERN/LHCC/99-14, ATLAS-TDR-014, 1999.

[2] ATLAS Collaboration, First-Level Trigger Technical Design Report, CERN/LHCC/98-14, 1998.

[3] ATLAS HLT/DAQ/DCS Group, ATLAS High-Level Trigger, Data Acquisition and Controls Technical Design Report, CERN/LHCC/2003-022, ATLAS-TDR-016, 2003.