ATLAS Trigger Menus for the LHC Start-up Phase

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with input from:
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Abstract

This note gives an overview of the ATLAS physics selection strategy for the initial running period of LHC and an assumed maximum luminosity of $2{\cdot}10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. We present various contributions to the trigger menu, ranging from inclusive and unprescaled physics triggers, through prescaled physics and monitoring triggers, to pure calibration and monitoring triggers. We also try to give motivations for the various choices of trigger items where appropriate and useful.

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Document History

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1 Introduction

This note summarizes ideas about trigger menus for the very first LHC running, i.e. for a maximal luminosity of $2{\cdot}10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. Several different types of information are collected:

- In Section 2 we discuss the general physics trigger menu as intended for collecting the bulk of data to be used for physics analyses. The selection is presented in terms of the LVL1 and HLT signatures in an obvious notation already well familiar to ATLAS. Where possible information on the expected rates is also provided, together with a short comment on what the main purpose of the signature is. All triggers mentioned in this menu are unprescaled, most of them representing inclusive selections, and the thresholds mentioned are compromises between efficiency and background rejection.

- In addition to the general menu just mentioned, a few additional signatures with increased thresholds and flagged as 'high priority' are meant to be particularly sensitive to high-p_T objects. In Section 3 these additional signatures, together with the general information from Section 2, are presented. It is assumed that the total rate for this detailed menu is the same as for the general menu of Section 2 since the signatures with increased thresholds are included already.

- There exist, however, a large number of triggers which will either be prescaled (due to their high rate or because they select less interesting physics channels) or which do not primarily serve for collecting data for physics analyses, but provide monitoring and calibration data. They might also be used for trigger efficiency determinations. These triggers are shown and discussed in Section 4, together with first ideas on necessary sample sizes. In the Section 4 we also present more exclusive signatures (either prescaled or unprescaled) which serve for selecting well-defined signatures which, assuming sufficiently low threshold values, have too high rates in more inclusive triggers. These exclusive signatures are primarily foreseen for triggering new physics processes or B events.

The information collected in this note comes from various sources, mainly the LVL1 TDR [1] and various talks given at ATLAS physics workshops or LHCC sessions [2, 3, 4]. An earlier effort for defining ATLAS trigger menus can be found, for example, in [5].

In an appendix we present in addition some of the feedback provided by the physics working groups in response to the first proposal of the trigger menus in this note (see [6] for an example of the feedback). As a reaction to this feedback, some items in the menu have changed or might still change in the near future.

The impact of the trigger menus shown in this document on the requirements for the LVL1 trigger system is discussed in a separate document [7]. The emphasis there is on the number of input bits to the CTP (or 'thresholds') and, even more, on the the number of available LVL1 output signals (or 'trigger items' in LVL1 nomenclature). It is assumed that this document may influence the final design of the CTP.

2 The General Physics Menu

In this section we show, in Table 1, a general trigger menu intended for initial LHC running at a peak luminosity of $2{\cdot}10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. This trigger menu contains only unprescaled (inclusive) triggers to be used directly for physics purposes (no calibration, monitoring or other technical triggers). Where available, we tried to gather information about the rates to be expected at LVL1 and in the HLT. In addition, a short comment illustrates the purpose of the trigger.

The content of Table 1 is a compilation of information gathered for recent presentations at conferences and at the LHCC [2] and, especially for the LVL1 signature parts, from the ATLAS LVL1 trigger Technical Design Report (TDR) [1]. The menus shown here aim for total rates of 25 kHz (LVL1) and 200 Hz (HLT)[1] at peak luminosity, respectively. Assuming a design capability of 75 kHz at LVL1, this would leave room for some additional triggers (B physics, more general physics triggers), especially towards the end of an LHC fill. It must, however, be noted that rate estimates are based on Monte Carlo predictions which might easily be a factor 2 or more off. Therefore, some safety margin should also be planned in. In addition, the inclusion of more triggers should not increase the HLT output rate significantly above 200 Hz in view of the offline computing cost.

The notation in which the signatures are given is familiar to ATLAS since long. The convention is that LVL1 (HLT) signatures are written using capital (small) letters. The required multiplicity of the object in question is given as an integer in front of the string identifying the object, and the discriminating threshold to be applied is given as an integer after this string. The application of isolation criteria is indicated as an attached 'i'.

The main contributions to the menu are single and di-lepton triggers (at LVL1: MU20, 2MU6, EM25i, 2EM15i, and TAU60). These signatures are sensitive to most Standard Model and new physics processes involving known or new W and Z (W',Z') bosons. The thresholds of these signatures have been revised, mainly due to changed (more restrictive) rate constraints on the LVL1 trigger. The total rate at LVL1 is clearly dominated by the single and di-electron triggers; at HLT, the muon and electron final states contribute about 40 Hz each.

For QCD studies within the Standard Model, and for hadronic final states of new physics processes, a number of jet signatures with multiplicities between one and four required jets are provided. The precise definition of the thresholds will be one of the aims of new trigger studies which are just about to start.

From the remaining list, mainly the total transverse energy (indicated as 'E'), the total transverse energy as calculated from all jets ('JE') and the missing transverse energy ('xE') triggers should be mentioned. These provide sensitivity for Standard Model processes but are also an important ingredient for searches for new physics. The mixed signatures, consisting of lepton, jet and/or energy components are in many cases still under discussion, as are their respective threshold values.

[1] It should be noted that in these estimates the reduced anticipated initial funding has been taken into account so that the given rates are lower than would be desirable from a physics point of view. Please also note that the rates given here do not account for the slight reductions due to dead-time.

LVL1 Selection	LVL1 Rate [kHz]	HLT Selection	HLT Rate [Hz]	Examples of physics channels
MU20	0.8	μ20i	40	ttH,H→WW,ZZ, qq$\tau\tau$, W', Z', top,Z→ll
2MU"5"	0.2	2μ10 2μ"5"+mass etc.	10 10	H→WW,ZZ, Z→ll, B physics
EM25i	12	e25i γ60i	40 25	ttH,H→WW, W', Z', top, W→lν, Z→ll H→ $\gamma\gamma$
2EM15i	4	2e15i 2γ20i	<1 2	H→WW,ZZ, Z→ll H→ $\gamma\gamma$
TAU60	?	τ60	?	$H^{\pm} \rightarrow \tau\nu_{\tau}$
J200	0.2	j400	10	QCD, new phys.
2J170	?	2j350	?	–"–
3J90	0.2	3j165	10	–"–
4J65	0.2	4j110	10	–"–
FWDJ	?	fwdj	?	?
xE150	?	xE200	?	?
E1000	?	E1000	?	?
JE1000	?	jE1000	?	?
MU10+EM15i	0.1	μ10+e15i	1	H→WW,ZZ, tt fully leptonic
EM??+N·J	?	e??+N·J	?	low rate; thresholds + jet multiplicity t.b.d.
MU??+N·J	?	mu??+N·J	?	low rate; thresholds + jet multiplicity t.b.d.
EM20i+xE20-30	?	e20i+xE20-30	9	W→eν
TAU25+xE30	2	τ35+xE45	5	W→ $\tau\nu$, Z→ $\tau\tau$, new physics
J50+xE60	0.4	j70+xE70	20	SUSY
Prescaled, Technical, Monitoring	5		20	
Total	25		200	

Table 1: General Physics Trigger Menu for $2{\cdot}10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. The "5" in some of the muon trigger thresholds indicates that the precise value of the threshold is not yet defined.

3 The Detailed Physics Menu

In this section, a more detailed menu for unprescaled (mostly inclusive) physics is shown (Tables 2, 3), in which also high-priority triggers with higher thresholds enter, some of them with relaxed isolation critaria. The purpose of these high-priority items is mainly to override the complex dead-time algorithm of the CTP: In order to prevent derandomizers of the front-end electronics from filling up the CTP can be configured such that it accepts only N triggers in a time interval T, with N between 1 and 32 and T in the range 0 to 1.6 ms. More than N triggers in the interval T will be rejected, unless they are flagged as 'high priority'.

The rate of this menu is assumed to be the same as for the general physics case, since the higher threshold triggers do not add to the rate[2].

The most prominent additions of the detailed menu with respect to the general menu in Table 1 are the high-threshold electron triggers (LVL1: EM30, 40, 50, 60, 2EM30 with partly relaxed isolation criteria) which are discovery motivated. Additional thresholds are also foreseen for the τ final states and the jet and energy triggers.

[2]The jet rate decreases quickly with some power of the transverse momentum - an exponent of something like 6 is realistic (see F. Paige's mail in the appendix). Isolation criteria, on the other hand, have a rejection power of 10 or so. Therefore high-priority items with high sufficiently high p_T thresholds do not contribute to the rate even if only relaxed isolation criteria are applied.

Group	Multiplicity or Type	LVL1 Selection	HLT Selection	Comment
Muons	MU	MU20	μ20i	high priority
	2MU	2MU"5"	2μ"5"+mass etc.	J/Ψ, Y, rare B decays
		2MU10	2μ10	high priority
EM	EM	EM25i	e25i	
		EM30i	e30i	discovery motivated
		EM40i	e40i	discovery motivated
		EM50(i)	e50(i)	relaxed LVL1 (HLT?) isolation
				discovery motivated high priority
		EM60	e60	no LVL1 (HLT?) isolation
				discovery motivated high priority
	2EM	2EM15i	2e15i	
			2γ15i	
		2EM30i	2e30i	discovery motivated
			2γ30i	high priority
TAU	TAU	TAU60	τ60	
		TAU80	τ80	relaxed isolation high priority (?)
		TAU100	τ100	more relaxed isolation high priority (?)
		TAU120	τ120	ever more relaxed isolation high priority (?)

Table 2: Detailed physics menu for $2{\cdot}10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ assuming the same total rate as for the general physics menu. The "5" in some of the muon trigger thresholds indicates that the precise value of the threshold is not yet defined.

Group	Multiplicity or Type	LVL1 Selection	HLT Selection	Comment
Jets	J	J200	j400	
	2J	2J170	2j350	
	3J	3J90	3j165	
	4J	4J65	4j110	
	FWD	FWDJ	?	fwdj: 2·4 thresholds?
Energy	xE	xE150	xE200	
	E	xE200	xE300(?)	high priority
		E1000	E1000 (?)	
	JE	JE1000	jE1000	
Mixed	MU+EM	MU10+EM15i	μ10+e15i	
	EM+J	EM??+N·J	e??+N·J	low rate; thresholds + jet multiplicity t.b.d.
	MU+J	MU??+N·J	mu??+N·J	low rate; thresholds + jet multiplicity t.b.d.
	EM+xE	EM20i+xE20-30	e20i+xE20-30	
	TAU+xE	TAU25+xE30	τ35+xE45	
	J+xE	J50+xE60	j70+xE70	
		J90+xE90	j??+xE??	high priority
Prescaled, Technical, Monitoring				

Table 3: Continued detailed physics menu for $2{\cdot}10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ assuming the same total rate as for the general physics menu.

4 Prescaled Physics Triggers, Calibration and Monitoring Triggers

There exist a large number of triggers which will be prescaled. These do not primarily serve for collecting data for physics analyses, but provide important monitoring and calibration data or are foreseen for trigger efficiency determinations (for example via a bootstrap method[3]). These triggers are shown and discussed in this section.

No estimates for rates or prescale factors are given in this section - the optimum choice for these will depend on future studies. However, we try to provide first hints towards the requested size of the data samples for a given signature. This requested size may be driven by considerations about the statistical precision of measurements or efficiency determinations, for example.

Prescaled triggers fall into three categories, all of which are expected to give significant rate contributions (there might also be unprescaled calibration and monitor triggers):

- Prescaled physics triggers: They extend cross-section measuremens to smaller p_T values and might thus also help to understand backgrounds or selections cuts, for example.
- Calibration triggers: These triggers help to select samples of particles with well-known properties, for example Z→ee,$\mu\mu$, $b\overline{b}$ or W→jj. Using the known characteristics of these particles one can then use the events to calibrate the detector.
- Monitor triggers: These triggers help to control basic experimental properties like, for example, the vertex position or the luminosity.

In the following, the prescaled triggers given in Table 4 will be grouped in a few categories and motivated (many of the arguments apply equally well to many of the unprescaled inclusive triggers, and some of the examples will explicitly refer to those). In addition we show, in Table 5, a selection of exclusive trigger signatures which will be used to trigger on interesting (new physics) final states which give too high rates with the inclusive triggers with sufficiently low thresholds. The selection of signatures we show is not supposed to be complete but covers only a few channels from the Higgs and SUSY physics programme, and a few others. It should however be kept in mind that the discovery of new physics at the LHC might very well lead to the design of a number of exclusive triggers adapted to the (a priori unknown) corresponding final states.

[3]Starting from a sample of (unbiased) minimum-bias data the efficiency of a given trigger A might easily be determined via the ratio of triggered events to minimum bias events. The efficiency of a trigger B, with higher thresholds than A, can then be determined in a sample of events triggered by A, and so on.

4.1 Muon Triggers

The prescaled muon triggers will serve a variety of purposes.
• Using Z→ $\mu\mu$ events triggered by di-muon triggers like 2MU10 or 2MU15 helps to understand the momentum scale in the Inner Detector and muon spectrometer.
• MU6 triggers or other single muon low threshold triggers may be used to study the trigger efficiency using a bootstrap method.
• Single muon triggers at low thresholds also serve to understand muon reconstruction at low momentum, the energy loss of muons in the calorimeter or the alignment of the inner detector.
• The question of muon isolation still has to be discussed further.
• Z→ee,$\mu\mu$ events will also help with some questions arising from SUSY analyses (flavour subtraction).
• J/ψ,$\Upsilon \rightarrow \mu\mu$ events might also be used for mass and energy scale determinations.

4.2 Electron / Photon Triggers

• Di-electron events Z→ee at all kinds of (also low) thresholds like 2EM10, 2EM15 are essential for the understanding of the calorimeter energy scale and the detector intercalibration. The isolation criteria for these triggers still have to be discussed.
• Inclusive electron triggers with low thresholds (EM7, EM10, EM15, EM20), like inclusive muon triggers, serve for the determination of trigger efficiencies.
• Inclusive and di-electron triggers are also needed for the Inner Detector alignment, the understanding of the E/p and the determination of the reconstruction efficiencies.
• Single photon triggers may be used to map the material in the ATLAS tracking detectors, to study photon conversions or to investigate the photon reconstruction and detection efficiency.
• J/ψ decays to electron pairs may serve the determination of mass and energy scales.
• Z→ee events will also be used to tune the electron identification.

4.3 (b) Jet Triggers

• Di-jet events at low thresholds (2J25, 2J35, 2J50, 2J65, 2J90, 2J130) may serve for the detector intercalibration. In addition, they can be used to study jet reconstruction algorithms over the whole p_T range.
• Jet-plus-photon events may be used for the determination of the absolute jet energy scale.
• Like in the electron and muon trigger cases, jet triggers with lower thresholds may be used to determine jet trigger efficiencies.
• In addition, all kinds of jet triggers are vital for Standard Model QCD analyses.
• Jet events also have to be understood as a major background for many new physics searches.

• Jet events are further helpful in tuning Monte Carlo generators.
• $b\overline{b}H(b\overline{b})$ events or vector-boson fusion Higgs events $q\overline{q}H(b\overline{b})$ require the use of b tags for jets.

4.4 Energy Triggers

• Samples with reduced cuts on the missing transverse energy or reduced jet multiplicity events are required to understand the background to SUSY studies.

4.5 Mixed and Other Triggers

• Minimum-bias triggers and random triggers will be used to study the properties of the *pp* interaction.
• Minimum-bias events are also the basis for determining efficiencies of LVL1 triggers via, e.g., a bootstrap method.
• τ or $\tau + E_T^{miss}$ triggers from $Z\rightarrow \tau\tau$ with one leptonic and one hadronic τ decay may be used for general calibration purposes and to test the missing energy scale of the detector.

4.6 Exclusive Triggers

• Prescaled and unprescaled triggers including forward jets or localized forward energy depositions[4] in the FCAL and the endcaps, in conjunction with substantial missing transverse energy, might be used for triggering on invisible Higgs decays.
• Similarly, fwd jets plus leptons (e,μ,τ) can be used for triggering on Higgs bosons from vector-boson fusion events with the Higgs going W pairs or to τ pairs.
• $bb(H\rightarrow bb)$ events with four b jets in the final state can be triggered by the LVL1 three- or four-jet triggers and a more exclusive selection on HLT, requiring a number of b-tagged jets. It might be that the LVL1 thresholds have to be adapted for this trigger.
• Similarly, $qq(H\rightarrow bb)$ events might be selected using a refined LVL1 four-jet trigger.
• Lepton-lepton triggers (with two different leptons) might be signs for lepton flavour violation. In addition, fully leptonic top events or $H\rightarrow ZZ,WW$ events might be selected with them.
• Jet plus missing energy triggers are used for SUSY searches.
• Lepton plus missing energy triggers will play a role in improving the acceptance for $W\rightarrow l\nu$ events.
• Muon plus photon events selected at the HLT can be used to detect rare top decays or lepton flavour-violation events.

[4]It might be required to have energy in both forward regions with a certain correlation, for example a minimum rapidity separation.

LVL1 Selection	HLT Selection	Sample size	Purpose
MU"5"/10/15	μ"5"/10/15	$2.5{\cdot}10^7$?	ϵ, calibration alignment,
MU8	μ8 + B physics		B physics etc.
MU20 (unprescaled)	μ20 loose cuts	?	ϵ
2MU"5"/8	2μ"5"/8	?	thresholds tbd.
EM7i/10i/15i/20i	e7/10/15/20i	?	ϵ, calibration
	γ7/10/15/20i	?	alignment etc.
EM25i	e25 loose cuts	?	ϵ
EM25	e25,γ??	?	ϵ
EM30i	γ30i	?	HLT: pure γ, no e
EM40i	γ40i	?	–"–
EM60(i)	γ60(i)	?	loose cuts
2EM10,15	2e10,15	?	thresholds tbd.
	2γ10,15	?	thresholds tbd.
TAU25/35/45	τ25/35/45	?	
TAU60	τ60 loose cuts	?	ϵ
2TAU25,35	2τ25,35	?	thresholds tbd.
J25/35/50/65/90/130/170	j25/35/50/65/90/130/170/300	?	QCD, MC, ϵ,
2J25/35/50/65/90/130	2j25/35/50/65/90/130/170	?	calibration, algo, BG
3J25/35/50/65	3j25/35/50/65/75/90	?	
4J25/35/50	4j25/35/50/65/80	?	
FWDJ	fwdj	?	
xE30/60/90/120	xE45/70/90/120/160	?	
E400/600/800	E400/600/800	?	
JE400/600/800	jE400/600/800	?	
Calibration: 1-3 item (3 assumed)			
Random triggers: 1 prescaled			
prescaled BCID trigger filled/unpaired/empty: 3 items			
11 Additional items for roman pots, Lucid, beam pickups, ZDC.			

Table 4: Prescaled trigger menu for $2{\cdot}10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. The "5" in some of the muon trigger thresholds indicates that the precise value of the threshold is not yet defined.

LVL1 Selection	HLT Selection	Sample size	Purpose
EM?+TAU?	e?+τ?	?	tt leptonic,H→ZZ,WW lepton flavour viol.
MU?+TAU?	μ?+τ?	?	–"–
MU?+EM?	$\mu + \gamma$	?	exotics
EM20i+xE20-30	e20+xE20-30 loose cuts	?	W→eν,ϵ
TAU25+xE30	τ25+xE30 loose cuts	?	W→ $\tau\nu$,ϵ
J50+xE60	j70+xE70 loose cuts	?	ϵ
J25+xE30	j25+xE45	?	SUSY, SUSY BG excited quarks
J50+xE30	j?+xE45	?	–"–
J25+xE60	j25+xE?	?	–"–
FWDJ?+xE?	fwdj?+xE?		invisible Higgs
FWDJ?+MU?	fwdj?+μ?		Higgs in VBF with H→WW
FWDJ?+EM?	fwdj?+e?		Higgs in VBF with H→WW
FWDJ?+TAU?	fwdj?+τ?		Higgs in VBF with H→WW,$\tau\tau$
3J?,4J?	NJ? with M b tags		bb(H→bb) LVL1 unchanged
3J?,4J?	NJ? with M b tags		qq(H→bb)

Table 5: Selection of exclusive signatures for $2{\cdot}10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. Some of the triggers may exist in a prescaled and in an unprescaled version.

References

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

[2] F. Gianotti, **The ATLAS physics programme for the first LHC run**, talk given at the LHCC 10/2002, *http://agenda.cern.ch/age?a021034*.

[3] S. Tapprogge, **Physics requirements for the ATLAS High-Level Trigger**, ATL-DAQ-2000-033.

[4] S. Tapprogge, **Prescaled Triggers: Status of Survey on Needs**, talk given at the ATLAS physics workshop Lund 2001, *http://agenda.cern.ch/fullAgenda.php?ida=a0159#s15*

[5] S. George and T. Hansl-Kozanecka (eds.), **ATLAS Trigger Menus**, ATL-DAQ-NO-121, ATL-PHYS-NO-124.

[6] ATLAS Collaboration (Higgs Working Group), **Impact of New Trigger Menu on Higgs searches**, *http://cerutti.home.cernch/cerutti/new_trigger_menu.html*.

[7] N. Ellis, T. Schörner-Sadenius and S. Tapprogge, **ATLAS Trigger Menus: Impact on the CTP Design**, ATL-COM-DAQ-2003-011.

Appendix: Feedback from the Working Groups

In this section the physics working groups' feedback on the trigger menus shown in this note is summarized. Shown are the original email asking for feedback and the first feedbacks from the working groups. We do not show all of the discussions which centered around single points; these are all available from the following web page:

http://gianotti.web.cern.ch/gianotti/phys_trigger.html

The Original Request Mail

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Dear colleagues,

in the context of the HLT/DAQ TDR to be submitted in a few months
and the upcoming Athens workshop, we would like to ask you to
provide us with the following information.

As you know, during the last two years we were facing changes in
the start-up scenario for the LHC and in the initial trigger bandwidth,
and have adjusted our main high pT trigger menu accordingly for the
discussions with the LHCC.

In the attached PS file you will find an up-to-date version (page 1) of
the presently foreseen trigger menu for un-prescaled physics triggers.

We would like to ask you the following things:

-- To check this menu and to make sure that the signatures and the
   associated thresholds are ok for all the physics channels covered
   by your Working Group.

-- To report about any channel where you observe a loss in performance
   due to this "new" trigger menu, as compared to the Physics TDR.

-- As you will see, there are a few items of combined / more exclusive
   selections foreseen (in some cases the thresholds still need to be
   determined). Are there additional selections of this type which you
   need in order to extend the coverage ?

The second page shows first ideas on a set of pre-scaled triggers,
which could be used to perform cross-section measurements
over a larger kinematic range (i.e. extending to lower
thresholds), to better understand the background processes, etc.
Pre-scaled physics triggers are to be used also for the calibration
and alignment of the detector. Please note that in this table the
thresholds are meant to be indicative only.
We would like to ask you to provide us with a list of pre-scaled
triggers  you need for the various physics studies (Physics groups)
and for calibration/alignment purposes (Comb. Perf. groups).
In addition to specifying the trigger signatures and thresholds,
we ask you to indicate how many events you would like to have per
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year for a given signature. Please note that also here more exclusive
triggers could be added, if necessary.

We would appreciate very much if you could raise these issues during
the meeting of your Working Group next week and if we could gather a
first set of comments before the end of February, so that we can obtain
a crude overview. The next step would be to document this properly,
which should be done by the middle of April, so that we can include
the information in the HLT/DAQ TDR and have a discussion of the
whole picture in Athens.

Thank you very much in advance for your help in better understanding
the ATLAS needs for the first year(s) of physics running. Please do
not hesitate to contact us in case of questions.

Best regards,

Fabiola, Thomas and Stefan.

Exotics Working Group

From: Georges Azuelos <azuelos@LPS.UMontreal.CA>
Subject: RE: trigger issues for Athens and HLT TDR

Hi Stefan,
I don't have much to say about the trigger menu. In the exotics group,
most of the studies require fairly high energy particles and jets.
I wonder if a mu-gamma trigger would be possible with low threshold ~ 5
GeV. This would be for a study of lepton flavour violation, although we do
not expect a very good limit. Perhaps a prescaled trigger to study the
feasibility would do.
It seems difficult to have a b-trigger. If we could, b combined with a jet
could be useful for technicolor studies.
Could we have a double forward jet tag, for example 1 jet in eta > 2 and
one jet in eta < -2, with E > 300 GeV? The jet thresholds are in E_T or E?

Regards,
Georges

B Physics Working Group

From: Nick Ellis <Nick.Ellis@cern.ch>
To: Stefan Tapprogge <Stefan.Tapprogge@cern.ch>
Cc: Nick Ellis <nick.ellis@cern.ch>, fabiola.gianotti@cern.ch,
Paula Eerola <paula.eerola@cern.ch>
Subject: RE: trigger menus and physics coverage

Dear Stefan,

I have looked at your trigger menus wearing my B-physics hat.

Concerning the General Physics Trigger menu, I have the following
remarks:

- 2mu6 - we still need to study going to lower pT thresholds,
  possibly eta dependent - this should be flagged as a hope
  - it has the potential to significantly increase the B-physics
  statistics in the dimuon mode
- concerning the mass cuts for 2mu, these are not spelled out.
  I believe we must try to cover J/psi, psi' -> mu+mu- and
  also B -> mu+mu-(X) --- clearly for all these channels we
  can require an unlike-charge muon pair

- I would like to indicate that we hope to add an inclusive
  LVL1 muon trigger with low threshold (e.g. MU8), with ROI
  driven LVL2 and seeded EF - clearly this depends on technical
  feasibility that I hope will be established in the next
  months and sufficient resources being available.

Concerning the Prescaled Trigger Menu, I have the following
comments:

- We should try to get some inclusive muon data with even lower
  pT thresholds (possibly eta dependent)

- For the B-physics (and other physics too I think) we need large
  samples of events with min bias, very low threshold jets and
  very low threshold hadrons - these will be used to study the
  background to the muon sample due to pi/K decays - e.g. one
  can do an analysis where one "replaces" each hadron with a
  muon, keeping the rest of the event unchanged - Monte Carlo
  can be used to evaluate functions that give the probability
  for a hadron of given pT, eta to decay to "fake" a muon of
  reconstructed transverse momentum pTmu. Assuming that one wants
  O(10^4) events for each of O(100) bins in pT and eta, the
  order of magnitude sample size needed is 10^6.

Cheers Nick

SUSY Working Group

From: Frank E. Paige <paige@quark.phy.bnl.gov>

Fabiola, Thomas and Stefan:

The jet cross section behaves roughly like pt**(-k) at fixed energy; a
fit to the LO cross section in Isajet gives k=5.9 for 100<pt<1000GeV at
14TeV. Thus, take as a simple model for the jet cross section
        dN/dpt = A/pt0 (pt/pt0)**(-k)
where k \approx 6 and A is some constant.

Jets with pt = 0.95*pt0 are no less interesting than those with
pt=1.05*pt0, so we should make the trigger rate smooth at pt0. If we
want the trigger rate to be constant with pt below pt0, then the
appropriate prescale factor is

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        F = 1           , pt > pt0
          = (pt/pt0)**k , pt < pt0
This implies
        \int_{0}^{pt0}    dpt F*dN/dpt = A
        \int_{pt0}^\infty dpt F*dN/dpt = A/(k-1)
Uniform statistics in log(pt) would increase the fraction of events
below pt0; statistics proportional to pt would decrease it by a factor
of 2.

I conclude from this simple analysis that:

        (1) A smooth weighting function (presumably based on the HLT pt)
        may be preferable to a large number of discrete thresholds;

        (2) At least half and probably more of the rate for jets should
        be in prescaled triggers.

A similar argument applies for any smoothly falling distribution with no
obvious threshold. It does not apply, e.g., to di-photons, where we need
pt large enough to identify the photon and small enough to have good
efficiency for light Higgs decays. But I think a lot more attention
should be paid to prescaled physics triggers.

When we discussed this in the JetRec phone meeting yesterday, Anna
raised the point that multiple trigger thresholds provide redundancy for
understanding trigger efficiencies. This needs to be considered.

Frank
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Higgs Working Group

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From: Fabio CERUTTI <Fabio.Cerutti@cern.ch>

Dear Fabiola, Thomas and Stefan,
Elzbieta and myself have performed the first exercise of
checking the impact of the new HLT proposed menu on the main
Higgs searches. We have produced the following web page:

http://cerutti.home.cern.ch/cerutti/new_trigger_menu.html

This first look is still quite superficial and it is based in comparing
analyses cuts with trigger thresholds (no full simulation
of trigger threshold efficiency included). As you can see
from the tables in some cases we have pointed out that the new trigger
thresholds are higher than the selection cuts but we
don't have quantitative results (in terms of S/sqrt(b)). For this
reason we are pushing people in our group to cross check
the performance of their analyses with "NEW trigger cuts included"
(as analysis cuts) to provide some numbers based on Fast and (when
available) on Full simulation. When available the preliminary
results based on these studies are included in the attached tables.

In parallel we are also studying the possibility to have more
exclusive trigger (in particular for channels with multijets,
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forward jets, taus and missing Et) based on combinations of
existing LV1 threshold (we should fix at a certain point
the trigger menu for forward jets).

The goal is not to abandon the "inclusive trigger" approach
but to study the possibility to have some backup or higher
performance trigger to use in case of "HOT" channels or problems with bkg.
for some of the inclusive triggers (with consequent increase in thresholds).
These studies are going on and I'm confident that some of them will already be
presented at the next Higgs working group meeting. We
will update the web page with the information we get in
real time and inform you about these updates regularly (as an example some
studies on Vector-Boson-Fusion channels performed by the
Wisconsin group are expected soon, probably this week).

We are looking forward to receive your comments on this
preliminary study and to discuss with you about the proposed
exclusive triggers (when studies are available) and other trigger
arguments like forward-jet trigger.

In future we would also like to include an updated
"Trigger Selection routine" in ATLFAST based
on the HLT-TDR full simulation results.

With kind regards,
Elzbieta and Fabio.

Combined Muon Working Group

From: Aleandro Nisati <Aleandro.Nisati@cern.ch>

Dear Fabiola,

concerning the list of prescaled triggers we think we need for
the overall muon reconstruction, we confirm what has been
proposed at the time of the Lund physics workshop:

1) a sample of low pt muons, say with pT > 6 GeV; a statistics
from 10 to 100M should be ok; 5 Hz would be ok.

2) a sample of high-pt muons, pt>20 GeV; also in this case a few
Hz rate is ok.

I hope this answers to your question.

In case not, please let us know.

regards
leandro , jean-francois

Jet/Tau/ETmiss WG

From M. Bosman:

1) Jets triggers

The menu is provided for an initial luminosity of 2.10**33cm**-2s**-1
together with a proposal for prescaled trigger. The jet trigger purpose is QCD
and new physics (compositeness, resonances ...). Thresholds are set to fit into
an allowed bandwidth of the order of 25 Hz at the end of the chain.
In case of prescaled jet trigger, a large number of different thresholds is
proposed to accomodate the rapidly varying cross-section with pT.

Frank Paige (see also discussion in SUSY group) pointed out that the jet
cross-section below threshold is also interesting for physics. Here are some of
his arguments:
Jets at low pt are interesting because they probe QCD and the parton
distributions at low x, a region not accessible at lower energies.
Forward jet tags and central jet vetos are crucial for WW -> h studies.
Low-pt jets are also needed for complex signatures such as SUSY.

What is the implication of keeping a certain statistics of events
below threshold. For example, if one wants to have uniform statistics as a
function of pT below threshold, then the ratio of events above threshold to
the one below threshold is 1/(k-1) where k is the exponent of the pT distribution.
Given that k is of the order of 6, this means 80% below and 20% of events
above threshold. Requesting uniform statistics in log(pT) instead of pT, would
increase the fraction of events below threshold.
Adjusting to the desired level of statistics below threshold can be achieved by
applying a weight dependent on the pt of the jet as reconstructed in the trigger.
Although applying a continuous weight makes it difficult to have a quick
control on trigger efficiencies as it is the case when controlling simply how
many events passed a certain trigger threshold. In addition, one starts from the
"quantified" situation of the LvL1 result where the electronics foresee a set of
8 different thresholds apply to a group of towers (0.1x0.1). The sharpness of
the onset of the efficiency curve folded with the very steep pT distribution at
LvL1 will determine the output of LvL1. To be able to objectively answer the
question if it is useful or not to have "continuous" weights at LvL2 and EF, one
has to simulate the full chain, understanding the effect of the resolution at each
level, its effect on the rate, the limitation on the bandwidth, etc..

The choice of strategy will be done to match the interest for physic of the various
samples and see how one can optimally collect the interesting events. So, on one
hand, we should understand the "physics requirements". How we want to share
the allocated bandwidth to the huge pT range covered by jets. On the other hand
detailed simulation of the full trigger chain are needed to define how to establish
the main trigger thresholds, how to share the bandwidth with prescaled triggers.

There is also interest for a forward jet trigger, that if possible at LvL1, it could
be refined at HLT.

2) ETmiss

xE200: given a bandwidth, it will need detailed simulation
to establish what threshold is viable.

3) Tau

Single tau 60: this is new in the physics trigger menu.
Since there is also ETmiss in that trigger, it should
overlap significantly with the tau25+xE30.
Is it really needed?

Prescaled trigger
- tau25/35/45
since these triggers are domibated by QCD background, it
is rapidly varying with pT. Hence the necessity of different
threshold
- tau60 loose cuts for trigger efficiency
Rates for the Prescaled trigger could be studied

4) Mixed trigger

- tau35+xE45 (tau25+xE30)
This is used for A->tautau together with j70+xE70
Remark: if thresholds have to be raised, it is better to raise
ETmiss than tauET, more efficient in signal/background
The change from the old settings in parenthesis to new values
has been stuydied by Juergen Thomas: he evaluated a loss
of efficiency of 1-5 % w.r.t. lower thresholds
Preliminary study showed that the combination of both
triggers is about 5Hz
Possibility of using ETmiss isolation is under investigation
(see Michael Heldmann talk Higgs meeting 10.4.3)

prescaled = loose cut on tau or lowering xE threshold

- j70+xE70
In this case losse cuts means lowering thresholds