ATLAS Internal Note
DAQ-NO-054
17 June 1996

ATLAS Trigger Menus at Luminosity 10^{33} cm^{-2} s^{-1}

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Abstract

Sample trigger menus are proposed for the ATLAS LVL1, LVL2, and LVL3 triggers for luminosity 10^{33} cm^{-2} s^{-1}. These trigger menus are based on the ATLAS physics requirements. A catalog of physics processes studied by the ATLAS physics groups is included in an appendix, and trigger menu items for LVL1, LVL2, and LVL3 are proposed for each of these physics channels.

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1. Introduction

The intention of this note is to propose full LVL1, LVL2, and LVL3 trigger menus for the ATLAS trigger for luminosity $L=10^{33}$ cm^{-2} s^{-1}. These trigger menus are based on a catalog of physics processes studied by the ATLAS physics groups. The main references used for this catalog were the ATLAS Technical Proposal [1], the MSSM Higgs studies in Ref.[2], and recent SUSY Studies [3].

This note will be followed by a note describing the single-farm architecture for LVL2 (Architecture C) and a note proposing a model for LVL2 and LVL3 processing based on ATM switching networks. Notes describing the physics requirements, trigger menus, and processing model for high luminosity (10^{34} cm^{-2} s^{-1}) will be prepared as soon as time permits.

2. Physics Processes

We have attempted to include in this note all the physics channels that have been analyzed by the ATLAS physics groups. We start with the physics channels discussed in Ref.[1]. Then we include additional analyses of MSSM Higgs channels from Ref.[2]. We have also tried to include SUSY physics channels discussed at the ATLAS SUSY Workshop in Stockholm in January 1996 [3] and the ATLAS LVL2 Workshop in Cracow in April 1996 [4]. We apologize for the inevitable errors and omissions of interesting physics channels and important references.

3. Trigger Algorithms

We have tried to make sure that each physics channel was represented by at least one trigger algorithm. We have not tried to list all possible triggers for each physics channel, although this would have been desirable. In many cases, additional overlapping trigger items are included in the full trigger menus, but have not been listed for each relevant physics channel. On the other hand, important trigger items have undoubtedly, and regrettably, been omitted. The authors would appreciate any comments which would help improve these trigger menus for later editions of this note.

4. Trigger Rates

The trigger rates indicated in this note are "best guess" trigger rates. When possible, rates are taken from the Technical Proposal and its backup documents [5],[6] and [7] for the muon triggers, [8],[9], and [10] for the calorimeter triggers. When a particular rate is unknown, we try to estimate it based on rejection factors that have been determined for less complex trigger algorithms. Real physics channels have been taken into account where possible, so that rates are not reduced below known physics channels such as leptonic decays of W's and Z's.

4.1 Jets and Missing-E_T

There have been, and still are, problems with the jet trigger rates, because the LVL1 jet trigger algorithms are still poorly defined. In particular, the rates and the efficiencies for low-E_T jet triggers depend on decisions which have not yet been made. The rates used here are "best guesses" based on fast-simulation studies by J. Bystricky; they will be revised and up-dated as soon as the hardware trigger is better understood. The trigger items considered in this note are limited to no more than six jets; jet multiplicities up to at least ten will be considered in a future version of the note.

B-jet tagging is used in the LVL3 trigger menu. We assume that the B-jet tag gives a rejection for non-B jets by a factor 10 at LVL3 for low luminosity. This should be compared to the factor of 100 quoted in the Technical Proposal (Section 11.3.1) as a possible rejection factor for 50% efficiency for B jets with an E_T of 15 GeV.

The missing-E_T triggers, as the jet triggers, are poorly understood. M. Wunsch [11]has been studying the influence of signal shape and beam-crossing identification (BCID) on missing-E_T. The LVL1 missing-E_T trigger rates used here are based on J. Bystricky's fast simulations and do not yet include pulse shaping and BCID. The LVL2 trigger rates which combine missing-E_T with other trigger objects are based on the missing-E_T resolution shown by Cavalli, et al, in Ref.[12] . We assume a missing-E_T resolution corresponding to a total E_T which is twice the sum of the E_T thresholds for the other trigger objects. Furthermore, we assume, conservatively, that the missing-E_T resolution for the LVL3 (or LVL2) trigger is about two-times bigger than the ultimate resolution shown by Cavalli, et al. Again, these trigger rates will be up-dated as more reliable estimates become available.

4.2 B-Physics Triggers

The B-physics trigger rates used here are based on the Technical Proposal [1] and recent work by M. Smizanska [13]. The LVL2 trigger conditions are based on the trigger muon RoI and the full TRT scan. This LVL2 trigger does not require the analysis of new RoIs defined by the TRT full scan. The LVL3 trigger conditions do include the analysis of the new RoIs in the SCT tracker. This separation of LVL2 and LVL3 algorithms is formal; it does not imply that these algorithms will necessarily be implemented in separate processor farms.

5. Notation

The notation for the analysis and trigger conditions follows the notation used in the Technical Proposal. Trigger objects at LVL1 are indicated by capital letters; those at LVL2 (and in the physics analysis) are indicated by small letters. Some examples are given in the following table:

Trigger object	E_T threshold	Conditions	LVL1 object	LVL2 object
mu+-	6 GeV		MU6	mu6
mu+-	6 GeV	isolation	MU6I	mu6I
EM cluster	80 GeV		EM80	em80
gamma	15 GeV	isolation		g15I
e+-	20 GeV	isolation		e20I
tau+-	80 GeV		TAU80	tau80
h+-	80 GeV	isolation		h80I
jet	100 GeV		J100	j100
jet	15 GeV	B-jet tag		b15
missing-E_T	100 GeV		ME100	me100

The symbol “hh15” used in the B-physics menu items indicates that the combined p_T of the hadrons must exceed 15 GeV/c. Mass cuts and transverse mass cuts to select particle “X” are denoted M(X) and M_T(X) respectively.

6. Trigger Menus

The trigger levels referred to in this note have the following characteristics:

LVL1 refers to the standard LVL1 trigger. These LVL1 algorithms select events for the LVL1 trigger based on highly inclusive algorithms. The LVL1 trigger algorithms are based on low-p_T and high-p_T muons in the muon trigger chambers and on EM clusters, jets, and missing-E_T in the calorimeters. In addition, LVL1 trigger algorithms for narrow τ jets have been included in the trigger menus presented here.

LVL1.5 refers to flags set by the standard global LVL1 trigger processor. The LVL1.5 trigger rate is identical to the LVL1 trigger rate. The LVL1.5 flag signals those RoIs which are needed for the LVL2 algorithms. Use of the LVL1.5 flags reduces the number of RoIs that have to be processed by the (parallel or sequential)LVL2 processors.

LVL2 refers to the standard LVL2 trigger. The LVL2 algorithms are more complex than those indicated in the Technical Proposal. In the Technical Propoposal, the LVL2 algorithms confirmed the LVL1 trigger, but they did not introduce information from non-trigger RoIs. The LVL2 algorithms presented here include the non-trigger RoIs flagged at LVL1 (referred to here as LVL1.5). On the other hand, missing-E_T calculations and B-jet tags (based on impact parameters) are defined as LVL3 algorithms.

LVL2.5 refers to flags which can be set at LVL2, but which do not significantly reduce the LVL2 trigger rate. If the LVL3 trigger algorithm is different from the LVL2 algorithm, but does not include missing-E_T or B-jet tags, then it is also listed as a LVL2.5 item.

LVL3 algorithms include missing-E_T calculations and B-jet tags. They may be executed in the same processor farm as the LVL2 algorithms, or in a separate LVL3 processor farm, depending on the LVL2 and LVL3 architectures.

LVL3.5 refers to flags which can be set at LVL3, but which do not significantly reduce the LVL3 trigger rate.

6.1 LVL1 Trigger Menu at L=10^{33}

This standard LVL1 trigger menu is very similar to the LVL1 trigger menu in the T.P. The isolated EM cluster (which has already been included in the trigger simulation studies) has been added. A τ trigger item has been added. The jet and missing-E_T thresholds have been reconsidered, and the corresponding trigger rates have increased significantly. The 100 GeV jet trigger item now corresponds to a LVL1 threshold which will give 90% efficiency for LVL2 (or off-line) jets with E_T = 100 GeV. The total LVL1 trigger rate has been increased from the T.P. value of 23 kHz to the present value of 38.7 kHz, still a factor two below the CORE costing limit of 75 kHz.

The proposed LVL1 trigger menu for luminosity 10^{33} cm^{-2} s^{-1} is shown in the following table:

LVL1	MU6	8 000 Hz
LVL1	EM80	200 Hz
LVL1	EM20I	10 000 Hz
LVL1	EM15I + EM15I	2 500 Hz
LVL1	TAU80	5 000 Hz
LVL1	J100	8 000 Hz
LVL1	J50 + J50 + J50	3 000 Hz
LVL1	ME100	2 000 Hz
	TOTAL LVL1 TRIGGER RATE	38700 Hz

The LVL1 trigger rate can be reduced slightly, from 38 700 Hz to 38 460 Hz, by correcting for certain overlapping trigger items, as discussed in the following section.

Note that the three-jet trigger is not required for the physics channels studied in this note; four jets could be required, with a reduced rate of 600 Hz. Likewise, the LVL1 missing E_T threshold could be raised to 150 GeV/c, with a rate of only 30 Hz. Both of these changes are compatible with the LVL2 trigger menu shown in Section 6.3. The revised LVL1 trigger rate would then be 34 330 Hz, or 34 270 Hz after corrections for overlapping trigger items.

6.2 LVL1.5 Trigger Menu at L=10^{33}

The LVL1.5 trigger menu consists of a series of trigger flags to guide the LVL2 processing. Non-trigger RoIs found at LVL1 need not be processed at LVL2 unless they are required for one of the LVL1.5 trigger items. Many of these non-trigger RoIs are jets with E_T > 15 GeV; the trigger rates for these 15 GeV jets is very poorly understood at this time, as discussed in Section 4 of this note.

The proposed LVL1.5 trigger menu items for luminosity 10^{33} cm^{-2} s^{-1} are shown in the following table:

LVL1	MU6	8 000 Hz
LVL1.5	MU20	400 Hz
LVL1.5	MU20 + MU6	100 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL1.5	MU20 + EM15I	40 Hz
LVL1.5	MU20 + TAU40	400 Hz
LVL1.5	MU20 + J15 + J15 + J15 + J15 + J15 + J15	75 Hz
LVL1.5	MU20 + J15 + J15 + J15 + J15 + J15	100 Hz
LVL1.5	MU20 + J15 + J15 + J15 + J15	150 Hz
LVL1.5	MU20 + J15 + J15 + J15	200 Hz
LVL1.5	MU20 + J15 + J15	300 Hz
LVL1.5	MU20 + J15	400 Hz
LVL1.5	MU20 + J40 + J40	40 Hz
LVL1.5	MU6 + EM15I	800 Hz
LVL1.5	MU6 + MU6	400 Hz
LVL1.5	MU6 + MU6 + MU6	20 Hz
LVL1.5	MU6 + MU6 + EM15I	40 Hz
LVL1.5	MU6 + EM15I + EM15I	40 Hz
LVL1.5	MU6 + J15 + J15 + J15 + J15 + J15 + J15	1 500 Hz
LVL1.5	MU6 + J15 + J15 + J15 + J15 + J15	2 000 Hz
LVL1.5	MU6 + J15 + J15 + J15 + J15	3 000 Hz
LVL1.5	MU6 + J15 + J15 + J15	4 000 Hz
LVL1.5	MU6 + J15 + J15	6 000 Hz
LVL1	EM80	200 Hz
LVL1.5	EM80 + EM80	30 Hz
LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + TAU40	3 000 Hz
LVL1.5	EM20I + J15 + J15 + J15 + J15 + J15 + J15	1 800 Hz
LVL1.5	EM20I + J15 + J15 + J15 + J15 + J15	2 500 Hz
LVL1.5	EM20I + J15 + J15 + J15 + J15	3 500 Hz
LVL1.5	EM20I + J15 + J15 + J15	5 000 Hz
LVL1.5	EM20I + J15 + J15	7 000 Hz
LVL1.5	EM20I + J15	10 000 Hz
LVL1.5	EM20I + J40 + J40 + J40	200 Hz
LVL1.5	EM20I + J40 + J40 + J15 + J15 + J15 + J15	350 Hz
LVL1.5	EM20I + J40 + J40 + J15 + J15 + J15	500 Hz
LVL1.5	EM20I + J40 + J40 + J15 + J15	700 Hz
LVL1.5	EM201 + J100 + J100	250 Hz
LVL1	EM15I + EM15I	2 500 Hz
LVL1.5	EM15I + EM15I + EM7I	1 000 Hz
LVL1	TAU80	5 000 Hz
LVL1.5	TAU150	1 000 Hz
LVL1.5	TAU80 + TAU80	800 Hz

LVL1	J100	8 000 Hz
LVL1.5	J200	250 Hz
LVL1.5	J100 + J100	2 000 Hz
LVL1.5	J100 + J100 + ME100	300 Hz
LVL1.5	J100 + J100 + J100	200 Hz
LVL1.5	J100 + J100 + J100 + J100	20 Hz
LVL1.5	J100 + J15 + J15 + J15 + J15 + J15	2 000 Hz
LVL1.5	J100 + J15 + J15 + J15 + J15	3 000 Hz
LVL1.5	J100 + J15 + J15 + J15	4 000 Hz
LVL1	J50 + J50 + J50	3 000 Hz
LVL1.5	J50 + J50 + J50 + J50	600 Hz
LVL1.5	J50 + J50 + J50 + J50 + J50	100 Hz
LVL1.5	J50 + J50 + J50 + J50 + J50 + J50	20 Hz
LVL1	ME100	2 000 Hz
LVL1.5	ME150	30 Hz
TOTAL LVL1 (LVL1.5) TRIGGER RATE		38 700 Hz

Two of the LVL1.5 trigger items explicitly overlap more than one LVL1 trigger item. The item "MU6 + EM15I + EM15I" satisfies the LVL1 conditions "EM15I + EM15I" and "MU6". The item "J100 + J100 + J100" satisfies the LVL1 conditions "J100" and "J50 + J50 + J50". Correcting for this double-counting reduces the LVL1 trigger rate to 38 460 Hz.

There are a total of 51 LVL1.5 trigger menu items. The number of trigger thresholds required for each trigger object is given in the following table:

	Number of thresholds	
Trigger object	LVL1	LVL1.5
Low-p_T muon	1	1
High-p_T muon	1	1
EM cluster	3	4
Jet	2	5
τ, hadron	1	2
Missing-E_T	1	2

6.3 LVL2 Trigger Menu at L=10^{33}

The proposed LVL2 trigger menu for luminosity 10^{33} cm^{-2} s^{-1} is shown in the following table:

LVL2	mu40	25 Hz
LVL2	mu20I	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL2	mu20 + j15 + j15 + j15	50 Hz
LVL2	mu15I + e15I	1 Hz
LVL2	mu6I + mu6I	10 Hz
LVL2	e15I + e15I	8 Hz
LVL2	mu6I + j15 + j15	200 Hz
LVL2	e80	20 Hz
LVL2	g40I	60 Hz
LVL2	e20I	200 Hz
LVL2	g20I + g20I	5 Hz
LVL2	tau150	200 Hz
LVL2	tau100I + tau100I	5 Hz
LVL2	h80I	2 Hz
LVL2	j500	1 Hz
LVL2	j400 + j400	1 Hz
LVL2	j200 prescale/100	1 Hz
LVL2	j150 + j150 prescale/100	1 Hz
LVL2	j100 + j100 + ME100	80 Hz
LVL2	j100 + j100 + j100 + j100	2 Hz
LVL2	j100 + j15 + j15 + j15	500 Hz
LVL2	j50 + j50 + j50 + j50	200 Hz
LVL2	ME150	30 Hz
	SUM of LVL2 triggers (except B-physics)	1 627 Hz

LVL2 B-PHYSICS TRIGGERS

LVL2	mu6 + e1 + e1	730 Hz
LVL2	mu6 + mu5 + mu3	8 Hz
LVL2	mu6 + e5 + mu3	8 Hz
LVL2	mu6 + h6 + h6 + hh15 + $M_T(B_d)$	100 Hz
LVL2	mu6 + h1.5 + h1.5 + h1.0 + $M_T(\phi^0)$ + $M_T(D_S)$	2 200 Hz
LVL2	mu6 + mu5	65 Hz
	SUM of LVL2 B-physics triggers	3 111 Hz
	SUM corrected for overlapping triggers	2 661 Hz
	TOTAL LVL2 TRIGGER RATE	4 288 Hz

The major contributions to the LVL2 trigger (excepting the B physics triggers) come from the following five physics channels:

$W + H \rightarrow \mu\,\nu + b\,\bar{b}$	$\Rightarrow$	mu6I + 2*j15	200 Hz
$W \rightarrow e\,\nu$	$\Rightarrow$	e20I	200 Hz
$W' \rightarrow \tau\,\nu$	$\Rightarrow$	tau150	200 Hz
$H^0 \rightarrow h^0\,h^0 \rightarrow b\,\bar{b}\;\;b\,\bar{b}$	$\Rightarrow$	j100 + 3*j15	500 Hz
SUSY -> multijets + miss-E_T	$\Rightarrow$	4*j50	200 Hz
subtotal for five major contributions			1 300 Hz

6.4 LVL3 Trigger Menu at $L=10^{33}$

The proposed LVL3 trigger menu for luminosity 10^{33} cm^{-2} s^{-1} is shown in the following table. The first column on the right gives the trigger rates for each LVL3 algorithm. The second (last) column eliminates obvious double counting as well as some of the double counting due to leptonic W and Z decays which pass more than one set of trigger algorithms.

LVL3	mu60	6 Hz	5 Hz
LVL3	mu40 + me40	1 Hz	1 Hz
LVL3	mu20 + mu20	5 Hz	5 Hz
LVL3	mu20 + g40I	0.3 Hz	0.3 Hz
LVL3	mu40I	5 Hz	3 Hz
LVL3	mu20I + me20	7 Hz	7 Hz
LVL3	mu20I + tau40I	0.4 Hz	0.4 Hz
LVL3	mu20I + mu10	3 Hz	2 Hz
LVL3	mu20I + e20I	0.4 Hz	0 Hz
LVL3	mu15I + e15I	1 Hz	1 Hz
LVL3	mu20 + b15 + b15 + j15 + j15 + j15 + j15	0.7 Hz	0.7 Hz
LVL3	mu20 + b15 + b15 + j15 + j15 + j15	1 Hz	0.5 Hz
LVL3	mu20 + b15 + b15 + j15 + j15	1.3 Hz	0.7 Hz
LVL3	mu20 + b15 + b15 + j15	1.5 Hz	0.8 Hz
LVL3	mu20I + b15 + j15 + j15 + j15 + j15 + j15	0.3 Hz	0.3 Hz
LVL3	mu20I + b15 + j15 + j15 + j15 + j15	0.5 Hz	0.3 Hz
LVL3	mu20I + b15 + j15 + j15 + j15	0.8 Hz	0.4 Hz
LVL3	mu20I + b15 + j15 + j15	1.4 Hz	0.7 Hz
LVL3	mu20I + b15 + j15	2 Hz	1 Hz
LVL3	mu20I + b15	2 Hz	1 Hz
LVL3	mu20I + j40 + j40	1 Hz	1 Hz
LVL3	mu10I + mu10I + M(Z)	2 Hz	2 Hz
LVL3	mu6I + mu6I + mu6I	0.3 Hz	0.3 Hz
LVL3	mu6I + mu6I + e15I	0.2 Hz	0.2 Hz
LVL3	e15I + e15I + mu6I	0.2 Hz	0.2 Hz
LVL3	mu6I + b15 + b15 + j15 + j15 + j15 + j15	1.5 Hz	1.5 Hz
LVL3	mu6I + b15 + b15 + j15 + j15 + j15	2 Hz	1 Hz
LVL3	mu6I + b15 + b15 + j15 + j15	2.5 Hz	1.3 Hz
LVL3	mu6I + b15 + b15 + j15	3 Hz	1.5 Hz
LVL3	mu6I + b15 + b15	2 Hz	1 Hz

LVL3	e150	2 Hz	2 Hz
LVL3	e80 + e80	0.3 Hz	0.3 Hz
LVL3	e80 + me40	0.3 Hz	0.3 Hz
LVL3	g80I	3 Hz	3 Hz
LVL3	g40I + me40	0.2 Hz	0.2 Hz
LVL3	e40I	7 Hz	5 Hz
LVL3	e20I + tau40I	4 Hz	4 Hz
LVL3	e20I + me20 + M_T(W)	6 Hz	6 Hz
LVL3	e20I + b15 + j15 + j15 + j15 + j15 + me20	0.4 Hz	0.4 Hz
LVL3	e20I + b15 + j15 + j15 + j15 + me20	0.7 Hz	0.4 Hz
LVL3	e20I + b15 + j15 + j15 + me20	1.1 Hz	0.6 Hz
LVL3	e20I + b15 + j15 + me20	1.5 Hz	0.7 Hz
LVL3	e20I + b15 + me20	1.5 Hz	0.8 Hz
LVL3	e20I + b15 + b15 + j15 + j15 + j15 + j15	0.7 Hz	0.7 Hz
LVL3	e20I + b15 + b15 + j15 + j15 + j15	1.0 Hz	0.5 Hz
LVL3	e20I + b15 + b15 + j15 + j15	1.3 Hz	0.7 Hz
LVL3	e20I + b15 + b15 + j15	1.5 Hz	0.8 Hz
LVL3	e20I + b15 + b15	1 Hz	0.5 Hz
LVL3	e20I + j40 + j40 + j40	1 Hz	1 Hz
LVL3	e20I + j40 + j40 + b15 + j15 + j15 + j15	0.3 Hz	0.3 Hz
LVL3	e20I + j40 + j40 + b15 + j15 + j15	0.5 Hz	0.3 Hz
LVL3	e20I + j40 + j40 + j15 + b15	0.8 Hz	0.4 Hz
LVL3	e20I + j100 + j100	2 Hz	2 Hz
LVL3	g20I + g20I	5 Hz	5 Hz
LVL3	e20I + e20I	3 Hz	0 Hz
LVL3	e20I + g40I	2 Hz	0 Hz
LVL3	e15I + e15I + e7I	0.5 Hz	0.5 Hz
LVL3	tau150 + me80	0.5 Hz	0.5 Hz
LVL3	tau100I + tau100I	5 Hz	5 Hz
LVL3	h80I	2 Hz	2 Hz
LVL3	j500	1 Hz	1 Hz
LVL3	j400 + j400	1 Hz	1 Hz
LVL3	j200 prescale/100	1 Hz	1 Hz
LVL3	j150 + j150 prescale/100	1 Hz	1 Hz
LVL3	j100 + j100 + me100	2 Hz	2 Hz
LVL3	j100 + j100 + j100 + j100	2 Hz	2 Hz
LVL3	b100 + b15 + b15 + j15 + j15 + j15	1 Hz	1 Hz
LVL3	b100 + b15 + b15 + j15 + j15	1.3 Hz	0.7 Hz
LVL3	b100 + b15 + b15 + j15	1.5 Hz	0.8 Hz
LVL3	j50 + j50 + j50 + j50 + j50 + j50	5 Hz	5 Hz
LVL3	b50 + b50 + j50 + j50 + j50	2.5 Hz	2.5 Hz
LVL3	j50 + j50 + j50 + j50 + me80	0.5 Hz	0.5 Hz
LVL3	me150	3 Hz	3 Hz
	SUM of LVL3 triggers (except B-physics)	135.3 Hz	
	SUBTOTAL (subtract overlapping triggers)		107.2 Hz
	total of 69 menu items		

LVL3 B-PHYSICS TRIGGERS		
LVL3	mu6 + e1 + e1 + M(J/ψ)	24 Hz
LVL3	mu6 + mu5 + mu3	8 Hz
LVL3	mu6 + e5 + mu3	8 Hz
LVL3	mu6 + h6 + h6 + + hh15 + M(B)	5 Hz
LVL3	mu6 + h1.0 + h1.0 + h1.0 + M(ϕ^0) + M(D_S)	50 Hz
LVL3	mu6 + mu5 + M(B)	3 Hz
	SUM of all LVL3 B-physics triggers	98 Hz
	TOTAL LVL3 TRIGGER RATE	205 Hz

7. Conclusions

Trigger menus for the LVL1, LVL2, and LVL3 ATLAS triggers at luminosity 10^{33} cm^{-2} s^{-1} have been proposed in this note, based on the ATLAS physics requirements. A catalog of trigger algorithms proposed for each of the physics channels discussed by the ATLAS physics groups is included as an appendix to this note.

The trigger menus presented here are intended as an improvement over the simple trigger menus presented in the T.P. These trigger menus can be used to compare the performance expected from various LVL2 and LVL3 trigger architectures.

The LVL1 trigger rate presented here is about half of the 75 kHz limit. The high-p_T trigger rates are about 1.6 kHz at LVL2 (without missing-E_T recalculation and B-jet tags) and 100 Hz at LVL3. B physics increases these trigger rates to about 2.2 kHz at LVL2 and 200 Hz at LVL3. The current limit at 100 MB/s output to permanent storage should be reconsidered in light of improvements in hardware performance that can be expected with the revised LHC planning.

Trigger menus for luminosity 10^{34} cm^{-2} s^{-1}will be prepared soon, based on a similar study of the ATLAS physics requirements at high luminosity.

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APPENDIX A

Catalog of Physics Processes and Proposed Trigger Menu Items

The catalog of ATLAS physics processes used to determine the trigger menus proposed in this note are taken almost entirely from the work of the ATLAS physics groups. The main references are the Technical Proposal [1] and the MSSM Higgs work presented by E. Richter-Was, et al, in Ref.[2]. (Although many of the back-up documents referred to in the T.P. have been used in the course of this work, we have not attempted to include all of these references explicitly in this report. They can be found in the reference list in the T.P.)

Our understanding of the jet and missing-E_T trigger requirements is based largely on work presented at the ATLAS SUSY Workshop in Stockholm in January 1996 and at the ATLAS LVL2 Workshop in Cracow in April 1996.

The $H^0 \rightarrow h^0 h^0 \rightarrow b\,\bar{b}\,b\,\bar{b}$ channel has been studied at Saclay, in collaboration with ANL and with E. Richter-Was and the ATLAS SUSY Working Group.

Heavy vector boson decays into electron pairs, muon pairs, and, especially τ-pairs, have been added without specific physics simulations, even at the parton level. Inclusive leptonic W and Z decays have been included as a physics source and for calibration. Inclusive single-particle triggers have also been included; their thresholds can be increased as needed to limit their impact on the total LVL3 trigger rate.

The rest of this appendix is the catalog of these physics processes and the proposed trigger algorithms. For each physics process, we give a reference to the relevant section of the Technical Proposal or a reference to a more specific physics analysis, as well as a (partial) set of cuts used in the physics analysis of low luminosity. In cases where the physics analysis was studied only at high luminosity, the cuts are flagged as high-luminosity cuts. In a very small number of cases, physics processes proposed for high luminosity have been left out of the present catalog.

For each physics process, sample LVL1, LVL2, and LVL3 trigger algorithms are proposed. LVL1.5, LVL2.5, and LVL3.5 flags are indicated where relevant. A future version of this note will attempt to propose a more complete set of trigger algorithms for each physics process.

A.1. Higgs Bosons

A.1.1. Light Higgs (80 GeV < M < 120 GeV)

$H \rightarrow \gamma\gamma$

Physics analysis reported in Section 11.2 of the Technical Proposal [1].

Physics	g40I + g25I	
LVL1	EM15I + EM15I	2500 Hz
LVL2	g20I + g20I	5 Hz
LVL3	g20I + g20I	5 Hz

$W + H \rightarrow e^{\pm} \nu + b\ \bar{b}$

Physics analysis reported in Section 11.3.2 of the Technical Proposal [1].

Physics	e30I + b15 b15	
LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + J15 + J15	7 000 Hz
LVL2	e20I	200 Hz
LVL2.5	e20I + j15 + j15	100 Hz
LVL3	e20I + b15 + b15	1 Hz

$W + H \rightarrow \mu^{\pm} + b\ \bar{b}$

Physics analysis reported in Section 11.3.2 of the Technical Proposal [1].

Physics	mu6I + b15 b15	
LVL1	MU6	8 000 Hz
LVL1.5	MU6 + J15 + J15	6 000 Hz
LVL2	mu6I + j15 + j15	200 Hz
LVL3	mu6I + b15 + b15	2 Hz

$t\ \bar{t} + H \rightarrow e^{\pm} + b\ \bar{b} + b\ \bar{b}$

Physics analysis reported in Section 11.3.3 of the Technical Proposal [1].
The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}).

Physics	e30I + b15 + b15 + b15	
LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + J15 + J15 + J15	5 000 Hz
LVL2	e20I	200 Hz
LVL2.5	e20I + j15 + j15 + j15	50 Hz
LVL3	e20I + b15 + b15 + j15	1.5 Hz

$t\bar{t} + H \rightarrow \mu^{\pm} + b\bar{b} + b\bar{b}$

Physics analysis reported in Section 11.3.3 of the Technical Proposal [1].
The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}).

Physics	mu6I + b15 + b15 + b15	
LVL1	MU6	8 000 Hz
LVL1.5	MU6 + J15 + J15 + J15	4 000 Hz
LVL2	mu6I + j15 + j15	200 Hz
LVL2.5	mu6I + j15 + j15 + j15	100 Hz
LVL3	mu6I + b15 + b15 + j15	3 Hz

$b\bar{b} + H \rightarrow b\bar{b} + b\bar{b}$

This channel was discussed in Section 11.3 of the Technical Proposal [1], but it was considered to be "impossible to trigger on efficiently, even at the initial lower luminosity." The physics cuts proposed here were developed for the process $H^0 \rightarrow h^0 h^0 \rightarrow b\bar{b} + b\bar{b}$ and presented by J. Bystricky at the ATLAS SUSY Workshop, Stockholm, January 1996 [3].

Physics	b100 + b15 + b15 + b15	
LVL1	J100	8 000 Hz
LVL1.5	J100 + J15 + J15 + J15	4 000 Hz
LVL2	j100 + j15 + j15 + j15	500 Hz
LVL3	b100 + b15 + b15 + j15	1.5 Hz

A.1.2. Intermediate Mass Higgs (130 GeV < M < 800 GeV)

$H \rightarrow Z Z^{*} \rightarrow e^{+} e^{-} e^{+} e^{-}$

Physics analysis reported in Section 11.5.2.1 of the Technical Proposal [1]. The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}). One of the lepton pairs is required to have a mass within 6 GeV of the Z mass; the other pair is required to have a mass greater than 20 GeV

Physics	e20 + e20 + e7 + e7 + M(Z) + M(Z*)	
LVL1	EM15I + EM15I	2 500 Hz
LVL1.5	EM15I + EM15I + EM7I	1 000 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e15I + e15I + e7I	0.5 Hz
LVL3	e15I + e15I + e7I	0.5 Hz

LVL1	EM15I + EM15I	2 500 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e20I + e20I	3 Hz
LVL3	e20I + e20I	3 Hz
LVL3.5	e20I + e20I + M(Z)	1 Hz

$H \rightarrow Z\,Z^{*} \rightarrow \mu^{+}\,\mu^{-}\,\mu^{+}\,\mu^{-}$

Physics analysis reported in Section 11.5.2.2 of the Technical Proposal [1].
The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}).

Physics mu20 + mu20 + mu7 + mu7 + M(Z) + M(Z^{*})

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

LVL1	MU6	8 000 Hz
LVL1.5	MU6 + MU6 + MU6	20 Hz
LVL2	mu6I + mu6I	10 Hz
LVL2.5	mu6I + mu6I + mu6I	0.3 Hz
LVL3	mu6I + mu6I + mu6I	0.3 Hz

$H \rightarrow Z\,Z^{*} \rightarrow e^{+}\,e^{-}\,\mu^{+}\,\mu^{-}$

Physics analysis reported in Section 11.5.2.3 of the Technical Proposal [1].
The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}).

Physics e20 + e20 + mu7 + mu7 + M(Z) + M(Z^{*})

LVL1	EM15I + EM15I	2 500 Hz
LVL1.5	MU6 + EM15I + EM15I	40 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e15I + e15I + mu6I	0.2 Hz
LVL3	e15I + e15I + mu6I	0.2 Hz

LVL1	MU6	8 000 Hz
LVL1.5	MU6 + MU6 + EM15I	40 Hz
LVL2	mu6I + mu6I	10 Hz
LVL2.5	mu6I + mu6I + e15I	0.2 Hz
LVL3	mu6I + mu6I + e15I	0.2 Hz

A.1.3. Higgs Sector in MSSM

A, $H \rightarrow \tau^{+}\,\tau^{-} \rightarrow \mu$ + hadrons

Physics analysis reported in ATLAS internal note PHYS-NO-51 [12].

Physics mu24I + tau40 + me18 + ...

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + TAU40	400 Hz
LVL2	mu20I	20 Hz
LVL2.5	mu20I + tau40I	0.4 Hz
LVL3	mu20I + tau40I	0.4 Hz

A, H$\rightarrow \tau^+ \tau^- \rightarrow$ e + hadrons

Physics analysis similar to that for mu + hadrons reported in ATLAS internal note PHYS-NO-51 [12].

Physics e24I + tau40 + me18 + ...

LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + TAU40	3 000 Hz
LVL2	e20I	200 Hz
LVL2.5	e20I + tau40I	4 Hz
LVL3	e20I + tau40I	4 Hz

A, H $\rightarrow \tau^+ \tau^- \rightarrow \mu$ + e

Physics analysis reported in ATLAS internal note PHYS-NO-51 [12].

Physics mu15 + e15 + me15 + ...

LVL1	MU6	8 000 Hz
LVL1.5	MU6 + EM15I	800 Hz
LVL2	mu15I + e15I	1 Hz
LVL3	mu15I + e15I	1 Hz

A, H $\rightarrow \mu^+ \mu^-$

Physics analysis reported in ATLAS internal note PHYS-NO-74 [2].

Physics mu20 + mu20

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

A $\rightarrow$ Z h $\rightarrow e^+ e^- + b\ \bar{b}$

Physics analysis reported in ATLAS internal note PHYS-NO-74 [2].

Physics e20 + e20 + b15 + b15 + M(Z)

LVL1	EM15I + EM15I	2 500 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e20I + e20I	3 Hz
LVL3	e20I + e20I	3 Hz
LVL3.5	e20I + e20I + M(Z)	1 Hz

$A \rightarrow Z\,h \rightarrow \mu^+\,\mu^- + b\,\bar{b}$

Physics analysis reported in ATLAS internal note PHYS-NO-74 [2].

Physics	mu20 + mu20 + b15 + b15 + M(Z)	
LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

$A, H \rightarrow t\,\bar{t} \rightarrow W\,b + W\,b \rightarrow e\,\nu\,b + j\,j\,b$

Physics analysis reported in ATLAS internal note PHYS-NO-74 [2].

Physics	e20 + j40 + j40 + b15 + b15	
LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + J40 + J40 + J15 + J15	700 Hz
LVL2	e20I	200 Hz
LVL2.5	e20I + j40 + j40 + j15 + j15	4 Hz
LVL3	e20I + j40 + j40 + b15 + j15	0.8 Hz

$A, H \rightarrow t\,\bar{t} \rightarrow W\,b + W\,b \rightarrow \mu\,\nu\,b + j\,j\,b$

Physics analysis reported in ATLAS internal note PHYS-NO-74 [2].

Physics	mu20 + j40 + j40 + b15 + b15	
LVL1	MU6	8 000 Hz
LVL1.5	MU20 + J40 + J40	40 Hz
LVL2	mu20I	20 Hz
LVL2.5	mu20I + j40 + j40	1 Hz
LVL3	mu20I + j40 + j40	1 Hz

$H^0 \rightarrow h^0\,h^0 \rightarrow \gamma\,\gamma\,b\,\bar{b}$

Physics analysis reported in ATLAS internal note PHYS-NO-74 [2].

Physics	g20I + g20I + b15 + j15	
LVL1	EM15I + EM15I	2 500 Hz
LVL2	g20I + g20I	5 Hz
LVL3	g20I + g20I	5 Hz

$H^0 \rightarrow h^0\,h^0 \rightarrow b\,\bar{b}\,b\,\bar{b} \rightarrow c\,\mu\,\nu\,j\,j\,j$

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + J15 + J15 + J15	200 Hz
LVL2	mu20 + j15 + j15 + j15	50 Hz
LVL3	mu20 + b15 + b15 + j15	1.5 Hz

$H^0 \rightarrow h^0 h^0 \rightarrow b \bar{b} b \bar{b} \rightarrow j\ j\ j\ j$

Physics analysis reported by J. Bystricky, ATLAS SUSY Working Group Meeting, CERN, March 1996.

Physics	b100 + b15 + b15 + b15	
LVL1	J100	8 000 Hz
LVL1.5	J100 + J15 + J15 + J15	4 000 Hz
LVL2	j100 + j15 + j15 + j15	500 Hz
LVL3	b100 + b15 + b15 + j15	1.5 Hz

A.1.4. Strongly Interacting Higgs

$W^+ W^+ \rightarrow e^+ e^+$

Physics analysis reported in Section 11.9.1 of the Technical Proposal [1].
The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}).

physics	e25 + e25 + ...	
LVL1	EM15I + EM15I	2 500 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e20I + e20I	3 Hz
LVL3	e20I + e20I	3 Hz

$W^+ W^+ \rightarrow \mu^+ \mu^+$

Physics analysis reported in Section 11.9.1 of the Technical Proposal [1].
The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}).

physics	mu25 + mu25 + ...	
LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

A.2. Top Quarks

A.2.1. Top Quark Mass

$t\bar{t} \rightarrow W\,b + W\,b \rightarrow e^{+}\,\nu\,b + j\,j\,b$

Physics analysis reported in Section 11.10.1.1 of the Technical Proposal [1].

physics e20I + j40 + j40 + b40 + M(j j)=M_T(W)

LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + J40 + J40 + J40	200 Hz
LVL2	e20I	200 Hz
LVL2.5	e20I + j40 + j40 + j40	1 Hz
LVL3	e20I + j40 + j40 + j40	1 Hz
LVL3.5	e20I + j40 + j40 + b40	0.3 Hz

$t\bar{t} \rightarrow W\,b + W\,b \rightarrow \mu^{+}\,\nu\,b + j\,j\,b$

Physics analysis reported in Section 11.10.1.1 of the Technical Proposal [1].

physics mu20I + j40 + j40 + b40 + M(j j)=M(W)

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + J40 + J40	40 Hz
LVL2	mu20I	20 Hz
LVL2.5	mu20I + j40 + j40	1 Hz
LVL3	mu20I + j40 + j40	1 Hz

$t\bar{t} \rightarrow W\,b + W\,\bar{b} \rightarrow e^{+}\,\nu\,b + e^{-}\,\nu\,\bar{c}\,e^{+}\,\nu$

Physics analysis reported in Section 11.10.1.2 of the Technical Proposal [1].

physics e20I + e20I + e15

LVL1	EM15I + EM15I	2 500 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e20I + e20I	3 Hz
LVL3	e20I + e20I	3 Hz

$t\bar{t} \rightarrow W\,b + W\,\bar{b} \rightarrow e^{+}\,\nu\,b + e^{-}\,\nu\,\bar{c}\,\mu^{+}\,\nu$

Physics analysis reported in Section 11.10.1.2 of the Technical Proposal [1].

physics e20I + e20I + mu15

LVL1	EM15I + EM15I	2 500 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e20I + e20I	3 Hz
LVL3	e20I + e20I	3 Hz

$t\bar{t} \rightarrow W\,b + W\,\bar{b} \rightarrow e^{+}\,\nu\,b + \mu^{-}\,\nu\,\bar{c}\,e^{+}\,\nu$

Physics analysis reported in Section 11.10.1.2 of the Technical Proposal [1].

physics mu20I + e20I + e15

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + EM15I	40 Hz
LVL2	mu20I	20 Hz
LVL3	mu20I + e20I	0.4 Hz

$t\bar{t} \rightarrow W\,b + W\,\bar{b} \rightarrow e^{+}\,\nu\,b + \mu^{-}\,\nu\,\bar{c}\,\mu^{+}\,\nu$

Physics analysis reported in Section 11.10.1.2 of the Technical Proposal [1].

physics mu20I + e20I + mu15

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU6	100 Hz
LVL2	mu20I	20 Hz
LVL3	mu20I + mu10	3 Hz

$t\bar{t} \rightarrow W\,b + W\,\bar{b} \rightarrow \mu^{+}\,\nu\,b + \mu^{-}\,\nu\,\bar{c}\,e^{+}\,\nu$

Physics analysis reported in Section 11.10.1.2 of the Technical Proposal [1].

physics mu20I + mu20I + e15

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

$t\bar{t} \rightarrow W\,b + W\,\bar{b} \rightarrow \mu^{+}\,\nu\,b + \mu^{-}\,\nu\,\bar{c}\,\mu^{+}\,\nu$

Physics analysis reported in Section 11.10.1.2 of the Technical Proposal [1].

physics mu20I + mu20I + mu15

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

A.2.2. Inclusive Top Quark Decays

$t\bar{t} \rightarrow W\,b + \bar{t} \rightarrow e^{+}\,\nu\,b + X$

Inclusive top decays can be selected by requiring a leptonic decay of the other top, $t \rightarrow W\,b \rightarrow$ lepton ν b. The trigger algorithm proposed here requires observation of the three particles (e, ν, b) from the top decay. Another possibility would be to trigger on an isolated electron plus a higher-energy b-jet (b40).

physics	e20I + b15 + me20	
LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + J15	10 000 Hz
LVL2	e20I	200 Hz
LVL2.5	e20I + j15	200 Hz
LVL3	e20I + b15 + me20	1.5 Hz

$t\bar{t} \rightarrow W\,b + \bar{t} \rightarrow \mu^{+}\,\nu\;b + X$

Inclusive top decays can be selected by requiring a leptonic decay of the other top, $t \rightarrow W\,b \rightarrow$ lepton ν b. The trigger algorithm proposed here requires only the μ plus the b-jet.

physics	mu20I + b15 + me20	
LVL1	MU6	8 000 Hz
LVL1.5	MU20 + J15	400 Hz
LVL2	mu20I	20 Hz
LVL2.5	mu20I + j15	20 Hz
LVL3	mu20I + b15	2 Hz

A.2.3. Rare Top Decays

$t\bar{t} \rightarrow W\,b + H^{-}\;\bar{b} \rightarrow e^{+}\,\nu\,b + \tau + \nu\;\bar{b}$

Physics analysis reported in Section 11.10.2 of the Technical Proposal [1].

physics	e20I + b20 + b20 + j20	
LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + J15 + J15 + J15	5 000 Hz
LVL2	e20I	200 Hz
LVL2.5	e20I + j15 + j15 + j15	50 Hz
LVL3	e20I + b15 + b15 + j15	1.5 Hz

$t\bar{t} \rightarrow W\,b + Z\,c \rightarrow j\,j\,b + e^{+}\,e^{-}\,c$

Physics analysis reported in Section 11.10.3 of the Technical Proposal. Specific thresholds for the leptons are not given in the T.P. Here, we have used the inclusive Z trigger algorithms. Additional algorithms requiring two leptons plus a b-jet should be included in the next version of the trigger menus.

physics	e + e + b50 + j50 + j50 + M(Z)

LVL1	EM15I + EM15I	2 500 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e20I + e20I	3 Hz
LVL3	e20I + e20I	3 Hz
LVL3.5	e20I + e20I + M(Z)	1 Hz

$t\,\bar{t} \rightarrow W\,b + Z\,c \rightarrow j\,j\,b + \mu^{+}\,\mu^{-}\,c$

Physics analysis reported in Section 11.10.3 of the Technical Proposal. Specific thresholds for the leptons are not given in the T.P. Here, we have used the inclusive Z trigger algorithms. Additional algorithms requiring two leptons plus a b-jet should be included in the next version of the trigger menus.

physics	μ + μ + b50 + j50 + j50 + M(Z)	
LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

A.3. SUSY Particles

SUSY $\rightarrow$ multi-jets + missing-E_T

Physics analysis reported in ATLAS internal note PHYS-NO-57 [14].

Physics	j200 + j200 + j200 + j100 + me300	
LVL1	J100	8 000 Hz
LVL1.5	J100 + J100 + J100 + J100	20 Hz
LVL2	j100 + j100 + j100 + j100	2 Hz
LVL3	j100 + j100 + j100 + j100	2 Hz
LVL1	J50 + J50 + J50	3 000 Hz
LVL1.5	J50 + J50 + J50 + J50	600 Hz
LVL2	j50 + j50 + j50 + j50	200 Hz
LVL3	j50 + j50 + j50 + j50 + me80	0.5 Hz
LVL1	ME100	2 000 Hz
LVL1.5	ME150	30 Hz
LVL2	ME150	30 Hz
LVL3	me150	3 Hz

SUSY $\rightarrow$ e + multi-jets + missing-E_T

Physics analysis reported by G. Polesello, ATLAS SUSY Workshop, Stockholm, January 1996 [3].

Physics	e20 + j100 + j100 + me100	
LVL1	EM20I	10 000 Hz
LVL1.5	EM20I + J100 + J100	250 Hz
LVL2	e20I	200 Hz
LVL2.5	e20I + j100 + j100	2 Hz
LVL3	e20I + j100 + j100	2 Hz

SUSY $\rightarrow$ μ + multi-jets + missing-E_T

Physics analysis reported by G. Polesello, ATLAS SUSY Workshop, Stockholm, January 1996 [3].

Physics	mu20 + j100 + j100 + me100	
LVL1	MU6	8 000 Hz
LVL1.5	MU20 + J40 + J40	40 Hz
LVL2	mu20I	20 Hz
LVL2.5	mu20I + j40 + j40	1 Hz
LVL3	mu20I + j40 + j40	1 Hz

SUSY $\rightarrow$ e^+ e^+ + multi-jets + missing-E_T

Physics analysis reported in Section 11.12.3 of the Technical Proposal [1].

Physics e20 + e20 + j70 + j70 + j70 + j70 + me120

LVL1	EM15I + EM15I	10 000 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e20I + e20I	3 Hz
LVL3	e20I + e20I	3 Hz

SUSY $\rightarrow$ μ^+ μ^+ + multi-jets + missing-E_T

Physics analysis reported in Section 11.12.3 of the Technical Proposal [1].

Physics mu20 + mu20 + j70 + j70 + j70 + j70 + me120

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

SUSY $\rightarrow$ e^+ μ^+ + multi-jets + missing-E_T

Physics analysis reported in Section 11.12.3 of the Technical Proposal [1].

physics mu20 + e20 + j70 + j70 + j70 + j70 + me120

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + EM15I	40 Hz
LVL2	mu20I	20 Hz
LVL3	mu20I + e20I	0.4 Hz

SUSY $\rightarrow$ e + e + e + missing-E_T

Physics analysis reported in ATLAS internal note PHYS-NO-61 [15].

physics e20 + e20 + e10 + me10 + ...

LVL1	EM15I + EM15I	2 500 Hz
LVL1.5	EM15I + EM15I + EM7I	1 000 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e15I + e15I + e7I	0.5 Hz
LVL3	e15I + e15I + e7I	0.5 Hz

SUSY $\rightarrow$ μ + μ + μ + missing-E_T

Physics analysis reported in ATLAS internal note PHYS-NO-61 [15].

physics mu20 + mu20 + mu10 + me10 + ...

LVL1	MU6	8 000 Hz
LVL1.5	MU6 + MU6 + MU6	20 Hz
LVL2	mu6I + mu6I	10 Hz
LVL2.5	mu6I + mu6I + mu6I	0.3 Hz
LVL3	mu6I + mu6I + mu6I	0.3 Hz

SUSY $\rightarrow$ e + e + μ + missing-E_T

Physics analysis reported in ATLAS internal note PHYS-NO-61 [15].

physics e20 + e20 + mu10 + me10 + ...

LVL1	EM15I + EM15I	2 500 Hz
LVL1.5	MU6 + EM15I + EM15I	40 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e15I + e15I + mu6I	0.2 Hz
LVL3	e15I + e15I + mu6I	0.2 Hz

SUSY $\rightarrow$ μ + μ + e + missing-E_T

Physics analysis reported in ATLAS internal note PHYS-NO-61 [15].
A trigger item should be added for mu20 + mu20 + e10 + me10 + ...

physics e20 + mu20 + mu10 + me10 + ...

LVL1	MU6	8 000 Hz
LVL1.5	MU6 + MU6 + EM15I	40 Hz
LVL2	mu6I + mu6I	10 Hz
LVL2.5	mu6I + mu6I + e15I	0.2 Hz
LVL3	mu6I + mu6I + e15I	0.2 Hz

SUSY $\rightarrow$ neutralino$_1$ neutralino$_2$ $\rightarrow$ γ + missing-E_T

Physics analysis reported by K. Hultqvist, ATLAS SUSY Workshop, Stockholm, January 1996 [3].

LVL1	EM20I	10 000 Hz
LVL2	g40I	60 Hz
LVL3	g40I + me40	0.2 Hz

SUSY $\rightarrow$ squark$_R$ squark$_R$ $\rightarrow$ j j + missing-E_T

Physics analysis reported by E. Richter-Was, ATLAS LVL2 Trigger Workshop, Cracow, April 1996 [4].

physics	j100 + j100 + me100	
LVL1	J100	8 000 Hz
LVL1.5	J100 + J100 + ME100	300 Hz
LVL2	j100 + j100 + ME100	80 Hz
LVL3	j100 + j100 + me100	2 Hz

SUSY $\rightarrow$ h^0 $\rightarrow$ b $\bar{b}$

Physics analysis reported in ATLAS internal note PHYS-NO-42 [7].

physics	b50 + b50 + j50 + j50 + j50 + j50 + me150	
LVL1	J50 + J50 + J50	3 000 Hz
LVL1.5	J50 + J50 + J50 + J50 + J50 + J50	20 Hz
LVL2	j50 + j50 + j50 + j50	200 Hz
LVL2.5	j50 + j50 + j50 + j50 + j50 + j50	5 Hz
LVL3	j50 + j50 + j50 + j50 + j50 + j50	5 Hz

SUSY $\rightarrow$ H^+ $\rightarrow$ t $\bar{b}$ $\rightarrow$ W+ b $\bar{b}$ $\rightarrow$ j j b $\bar{b}$

Physics analysis reported in ATLAS internal note PHYS-NO-35 [16].

physics	b50 + b50 + j50 + j50 + j50 + me120	
LVL1	J50 + J50 + J50	3 000 Hz
LVL1.5	J50 + J50 + J50 + J50 + J50	100 Hz
LVL2	j50 + j50 + j50 + j50	200 Hz
LVL2.5	j50 + j50 + j50 + j50 + j50	30 Hz
LVL3	b50 + b50 + j50 + j50 + j50	2.5 Hz
LVL1	J50 + J50 + J50	3 000 Hz
LVL1.5	J50 + J50 + J50 + J50	600 Hz
LVL2	j50 + j50 + j50 + j50	200 Hz
LVL3	j50 + j50 + j50 + j50 + me80	0.5 Hz

A.4. Heavy Vector Bosons

$Z' \rightarrow j\ j$

Physics analysis reported in ATLAS internal note PHYS-NO-10 [17].

physics	j150 + j150		
LVL1	J100		8 000 Hz
LVL1.5	J150 + J150		500 Hz
LVL2	j150 + j150	prescale/100	1 Hz
LVL3	j150 + j150	prescale/100	1 Hz

LVL1	J100	8 000 Hz
LVL1.5	J150 + J150	500 Hz
LVL2	j400 + j400	1 Hz
LVL3	j400 + j400	1 Hz

$Z' \rightarrow e^+ e^-$

Physics cuts for the dilepton decays are taken to be identical to the cuts proposed for dijet events in ATLAS internal note PHYS-NO-10 [17].

physics	e150 + e150	
LVL1	EM80	200 Hz
LVL1.5	EM80 + EM80	30 Hz
LVL2	e80	20 Hz
LVL2.5	e80 + e80	0.3 Hz
LVL3	e80 + e80	0.3 Hz

$Z' \rightarrow \mu^+ \mu^-$

Physics cuts for the dilepton decays are taken to be identical to the cuts proposed for dijet events in ATLAS internal note PHYS-NO-10 [17].

physics	mu150 + mu150	
LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz

$Z' \rightarrow \tau^+ \tau^-$

Physics cuts for the dilepton decays are taken to be identical to the cuts proposed for dijet events in ATLAS internal note PHYS-NO-10 [17].

physics	tau150 + tau150	
LVL1	TAU80	5 000 Hz
LVL1.5	TAU80 + TAU80	800 Hz
LVL2	tau100I + tau100I	5 Hz
LVL3	tau100I + tau100I	5 Hz

LVL1	JET100	8 000 Hz
LVL1.5	JET100 + JET100	2 000 Hz
LVL2	tau100I + tau100I	5 Hz
LVL3	tau100I + tau100I	5 Hz

$W' \rightarrow e^{\pm} \nu$

Physics analysis reported in ATLAS internal note PHYS-NO-59 [18].

physics e200 + me200

LVL1	EM80	200 Hz
LVL2	e80	20 Hz
LVL3	e80 + me40	0.3 Hz

$W' \rightarrow \mu^{\pm} \nu$

Physics cuts are taken to be identical to the cuts proposed for the electronic decays in ATLAS internal note PHYS-NO-59 [18].

physics mu200 + me200

LVL1	MU6	8 000 Hz
LVL1.5	MU20	400 Hz
LVL2	mu40	25 Hz
LVL3	mu40 + me40	1 Hz

$W' \rightarrow \tau^{\pm} \nu$

Physics cuts are taken to be identical to the cuts proposed for the electronic decays in ATLAS internal note PHYS-NO-59 [18].

physics tau200 + me200

LVL1	TAU80	5 000 Hz
LVL1.5	TAU150	1 000 Hz
LVL2	tau150	200 Hz
LVL3	tau150 + me80	0.5 Hz

LVL1	JET100	8 000 Hz
LVL2	tau150	200 Hz
LVL3	tau150 + me80	0.5 Hz

LVL1	ME100	2 000 Hz
LVL1.5	ME150	30 Hz
LVL2	ME150	30 Hz
LVL3	me150	3 Hz

A.5. Leptoquarks

quark gluon $\rightarrow$ lepton + LQ $\rightarrow$ lepton + lepton-jet

Physics analysis reported in Section 11.13.2 of the Technical Proposal. The cuts used in the physics analysis are for M = 1 TeV, but the search should start at 300 GeV.

physics	e300 + e300 + j300 + M(LQ) > 120	
LVL1	EM80	200 Hz
LVL1.5	EM80 + EM80	30 Hz
LVL2	e80	20 Hz
LVL2.5	e80 + e80	0.3 Hz
LVL3	e80 + e80	0.3 Hz

gluon gluon $\rightarrow$ LQ + LQ $\rightarrow$ lepton-jet + lepton-jet

Physics analysis reported in Section 11.13.2 of the Technical Proposal [1].

physics	e200 + e200 + j200 + j200	
LVL1	EM80	200 Hz
LVL1.5	EM80 + EM80	30 Hz
LVL2	e80	20 Hz
LVL2.5	e80 + e80	0.3 Hz
LVL3	e80 + e80	0.3 Hz

A.6. Compositeness

quark compositeness : single jets

Physics analysis reported in Section 11.13.3.1 of the Technical Proposal [1].

physics	j300	
LVL1	J100	8 000 Hz
LVL1.5	J200	250 Hz
LVL2	j200 prescale/100	1 Hz
LVL3	j200 prescale/100	1 Hz
LVL1	J100	8 000 Hz
LVL1.5	J200	250 Hz
LVL2	j500	1 Hz
LVL3	j500	1 Hz

lepton compositeness : di-leptons

Physics analysis reported in Section 11.13.3.2 of the Technical Proposal [1].

physics e400 + e400

LVL1	EM80	200 Hz
LVL1.5	EM80 + EM80	30 Hz
LVL2	e80	20 Hz
LVL2.5	e80 + e80	0.3 Hz
LVL3	e80 + e80	0.3 Hz

A.7. Gauge Boson Pair Production

$W\gamma \rightarrow e\nu + \gamma$

Physics analysis reported in Section 11.13.4.1 of the Technical Proposal [1].
The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}).

physics e40 + g100

LVL1	EM15I + EM15I	2 500 Hz
LVL2	g20I + g20I	5 Hz
LVL3	g20I + g20I	5 Hz
LVL3.5	e20I + g40I	2 Hz

$W\gamma \rightarrow \mu\nu + \gamma$

Physics analysis reported in Section 11.13.4.1 of the Technical Proposal [1].
The physics cuts shown are for high luminosity (10^{34} cm^{-2} s^{-1}).

physics mu40 + g100

LVL1	EM20I	10 000 Hz
LVL1.5	MU20 + EM15I	40 Hz
LVL2	g40I	60 Hz
LVL2.5	mu20 + g40I	0.3 Hz
LVL3	mu20 + g40I	0.3 Hz

$WZ \rightarrow e\nu + e^{+} e^{-}$

Physics analysis reported in Section 11.13.4.2 of the Technical Proposal [1].

physics e25I + e25I + e25I + M(Z) + M_T(W)

LVL1	EM15I + EM15I	2 500 Hz
LVL1.5	EM15I + EM15I + EM7I	1 000 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e15I + e15I + e7I	0.5 Hz
LVL3	e15I + e15I + e7I	0.5 Hz
LVL3.5	e15I + e15I + e15I	0.1 Hz

$W Z \rightarrow \mu \nu + \mu^+ \mu^-$

Physics analysis reported in Section 11.13.4.2 of the Technical Proposal [1].

physics mu25I + mu25I + mu25I + M(Z) + M_T(W)

LVL1	MU6	8 000 Hz
LVL1.5	MU6 + MU6 + MU6	20 Hz
LVL2	mu6I + mu6I	10 Hz
LVL2.5	mu6I + mu6I + mu6I	0.3 Hz
LVL3	mu6I + mu6I + mu6I	0.3 Hz

$W Z \rightarrow e \nu + \mu^+ \mu^-$

Physics analysis reported in Section 11.13.4.2 of the Technical Proposal [1].

physics e25I + mu25I + mu25I + M(Z) + M_T(W)

LVL1	MU6	8 000 Hz
LVL1.5	MU6 + MU6 + EM15I	40 Hz
LVL2	mu6I + mu6I	10 Hz
LVL2.5	mu6I + mu6I + e15I	0.2 Hz
LVL3	mu6I + mu6I + e15I	0.2 Hz

$W Z \rightarrow \mu \nu + e^+ e^-$

Physics analysis reported in Section 11.13.4.2 of the Technical Proposal [1].

physics mu25I + e25I + e25I + M(Z) + M(W)

LVL1	EM15I + EM15I	2 500 Hz
LVL1.5	MU6 + EM15I + EM15I	40 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e15I + e15I + mu6I	0.2 Hz
LVL3	e15I + e15I + mu6I	0.2 Hz

A.8. B-Physics

Physics analyses for the B physics channels were reported in Section 11.11.2 of the Technical Proposal. Recent progress on trigger rates was reported by M. Smizanska in Ref.[13]. Possible improvements to the LVL3 trigger algorithms are indicated as "LVL3.5" triggers; they will be incorporated into the LVL3 trigger menu as soon as we have more reliable estimations of the trigger reductions that can be obtained.

$\mu + B \rightarrow \mu + J/\psi + X \rightarrow \mu + e^+ e^- + X$

physics	mu6 + e1 + e1 + M(J/ψ) + B-vtx	
LVL1	MU6	8 000 Hz
LVL2	mu6 + e1 + e1	730 Hz
LVL3	mu6 + e1 + e1 + M(J/ψ)	24 Hz
LVL3.5	mu6 + e1 + e1 + M(J/ψ) + Bvtx	0.6 Hz

$\mu + B \rightarrow \mu + J/\psi + X \rightarrow \mu + \mu^+ \mu^- + X$

physics	mu6 + mu5 + mu3 + M(J/ψ) + B-vtx	
LVL1	MU6	8 000 Hz
LVL2	mu6 + mu5 + mu3	8 Hz
LVL3	mu6 + mu5 + mu3	8 Hz
LVL3.5	mu6 + mu5 + mu3 + M(J/ψ)	1.5 Hz ?

NOTE : 3 leptons with the same sign were rejected.

$e + B \rightarrow e + J/\psi + X \rightarrow e + \mu^+ \mu^- + X$

physics	e6 + mu6 + mu3 + M(J/ψ) + B-vtx	
LVL1	MU6	8 000 Hz
LVL2	mu6 + e5 + mu3	8 Hz
LVL3	mu6 + e5 + mu3	8 Hz
LVL3.5	mu6 + e5 + mu3 + M(J/ψ)	0.5 Hz ?

NOTE : Particle-level study only.

$\mu + B_d \rightarrow \mu + \pi^+ \pi^-$

physics	mu6 + h6 + h6 + M(Bd) + B-vtx + ...	
LVL1	MU6	8 000 Hz
LVL2	mu6 + h6 + h6 + hh15 + $M_T(B_d)$	100 Hz
LVL3	mu6 + h6 + h6 + hh15 + $M(B_d)$	5 Hz
LVL3.5	mu6 + h6 + h6 + hh15 + $M(B_d)$ + B-vtx	?

NOTE : The B mass cut were set at $\pm 5\,\sigma$ (250 MeV).

$\mu + B_S \rightarrow \mu + D^-_S\ \pi^+ \rightarrow \mu + \phi\,\pi^-\,\pi^+ \rightarrow \mu + K^+\,K^-\,\pi^-\,\pi^+$

physics	mu6 + h1.5 + h1.5 + h1.0 + $M(\phi^0)$ + $M(D_S)$	
LVL1	MU6	8 000 Hz
LVL2	mu6 + h1.5 + h1.5 + h1.0 + $M_T(\phi^0)$ + $M_T(D_S)$	2 200 Hz
LVL3	mu6 + h1.5 + h1.5 + h1.0 + $M(\phi^0)$ + $M(D_S)$	50 Hz
LVL3.5	mu6 + h1.5 + h1.5 + h1.0 + $M(\phi^0)$ + $M(D_S)$ + B-vtx	?

NOTE : Loose mass cuts were applied at LVL2, and tight mass cuts at LVL3.

$B \rightarrow \mu^+ \mu^-$

physics	mu6 + mu5 + M(B) + B-vtx	
LVL1	MU6	8 000 Hz
LVL2	mu6 + mu5	65 Hz
LVL3	mu6 + mu5 + M(B)	3 Hz
LVL3.5	mu6 + mu5 + M(B) + B-vtx	?

NOTE : The B mass cut extends from 80 MeV below the B_d mass to 80 MeV above the B_S mass.

A.9. Inclusive Triggers

A.9.1. Inclusive W and Z Leptonic Decays

$Z \rightarrow e^+ e^-$

LVL1	EM15I + EM15I	2 500 Hz
LVL2	e15I + e15I	8 Hz
LVL2.5	e20I + e20I	3 Hz
LVL3	e20I + e20I	3 Hz
LVL3.5	e20I + e20I + M(Z)	1 Hz

$Z \rightarrow \mu^+ \mu^-$

LVL1	MU6	8 000 Hz
LVL1.5	MU20 + MU20	20 Hz
LVL2	mu20 + mu20	5 Hz
LVL3	mu20 + mu20	5 Hz
LVL3.5	mu20I + mu20I	2.5 Hz

LVL1	MU6	8 000 Hz
LVL1.5	MU6 + MU6	400 Hz
LVL2	mu6I + mu6I	10 Hz
LVL3	mu10I + mu10I + M(Z)	2 Hz

$W \rightarrow e^{\pm} \nu$

LVL1	EM20I	10 000 Hz
LVL2	e20I	200 Hz
LVL3	e20I + me20 + M_T(W)	6 Hz

$W \rightarrow \mu^{\pm} \nu$

LVL1	MU6	8 000 Hz
LVL2	mu20I	20 Hz
LVL3	mu20I + me20	7 Hz

A9.2 Inclusive Single-Particle Triggers

Single non-isolated muon

LVL1	MU6	8 000 Hz
LVL2	mu40	25 Hz
LVL2.5	mu60	6 Hz
LVL3	mu60	6 Hz

Single isolated muon

LVL1	MU6	8000 Hz
LVL2	mu20I	20 Hz
LVL2.5	mu40I	5 Hz
LVL3	mu40I	5 Hz

Single non-isolated electron

LVL1	EM80	200 Hz
LVL2	e80	20 Hz
LVL2.5	e150	2 Hz
LVL3	e150	2 Hz

Single isolated electron

LVL1	EM20I	10 000 Hz
LVL2	e20I	200 Hz
LVL2.5	e40I	7 Hz
LVL3	e40I	7 Hz

Single isolated gamma

LVL1	EM20I	10 000 Hz
LVL2	g40I	60 Hz
LVL2.5	g80I	3 Hz
LVL3	g80I	3 Hz

Single isolated hadron

LVL1	TAU80	5 000 Hz
LVL2	h80I	2 Hz
LVL3	h80I	2 Hz

Single jet

LVL1	J100	8 000 Hz
LVL1.5	J200	250 Hz
LVL2	j500	1 Hz
LVL3	j500	1 Hz

Missing-E_T

LVL1	ME100	2 000 Hz
LVL1.5	ME150	30 Hz
LVL2	ME150	30 Hz
LVL3	me150	3Hz