Games with Trigger Tables

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Physics

Start with list of physics processes and typical offline cuts from Daniel Denegri and Vladimir Gavrilov (posted on JPG web page)

Physics cuts / Higgs - I

1) $H \to \gamma\gamma$

- Two isolated photons, $E_t(\gamma_1) > 40$ GeV, $E_t(\gamma_2) > 25$ GeV in $|\eta| < 2.5$

  isolation: no track with $p_t > 2.5$ GeV in cone $R = 0.3$ and $E_t^{em\ cell}$ in $R < 0.3$ less that 2.5 GeV

2) WH, ttH $\to \ell\gamma\gamma + X$

- Two isolated photons, $E_t(\gamma_1) > 40$ GeV, $E_t(\gamma_2) > 25$ GeV
- one isolated lepton: $p_t^{\ell} > 20$ GeV, $|\eta^{e,\mu}| < 2.5, 2.4$;
- $E_t^{miss} > 20$ GeV

3) $H (\to \gamma\gamma) +$ jets

- Two isolated photons, $E_t(\gamma_1) > 40$ GeV, $E_t(\gamma_2) > 25$ GeV
- $E_t(\gamma_1 + \gamma_2) > 50$ GeV
- 2 jets: $E_t^j > 40$ GeV if $|\eta| < 2.4$
  $E^j > 800$ GeV if $|\eta| > 2.4$
- $\Delta R(\gamma\text{-jet}) > 1.5$

4) $W (\to \ell\nu)\ H (\to bb)$

- one isolated lepton: $p_t^{\ell} > 20$ GeV, $|\eta^{e,\mu}| < 2.5, 2.4$;
- $E_t^{miss} > 20$ GeV
- only two central jets with $E_t > 25$ GeV in $|\eta^j| < 2.5$
  both jets b-tagged
- no other jets with $E_t > 25$ GeV in $|\eta^j| < 4.5$

5) $tt (\to \ell\nu + X)\ H (\to bb)$

- one isolated lepton: $p_t^{\ell} > 20$ GeV, $|\eta^{e,\mu}| < 2.5, 2.4$;
- $E_t^{miss} > 20$ GeV
- 6 central jets with $E_t > 25$ GeV in $|\eta^j| < 2.5$
  4 jets b-tagged

D.D. Tagl

First of 5 pages from Denegri...

Find channels that will probably need some jet/met requirement...

Trigger Tables

Start with Dasu's strawman L1 and Virdee's strawman L3 table, and see how it matches physics (both would be point out that this is unfair, that these are not supposed to be real trigger tables, but let's do it just for fun, anyway…)

(similar to some work Vladimir Gavrilov already did…)

L1

Physics at high luminosity

Trigger Type	Et Cutoff (GeV)	Rate (kHz)		
		Indiv.	Cumul.	Increm.
Sum Et	400	0.48	0.48	0.48
Miss Et	80	1.29	1.7	1.22
1 e	25	6.84	8.34	6.64
2 e	12	1.45	9.52	1.18
1 jet	100	2.06	10.7	1.16
2 jet	60	2.17	11.6	0.93
3 jet	30	3.16	13.3	1.7
4 jet	20	2.96	14.3	1.01
Jet + e	50 +12	1.35	14.9	0.59

$L = 10^{34}$ cm^{-2} s^{-1}

QCD Background

The sum and missing E_t cutoffs are chosen to give ~ 2 kHz.

e/γ triggers are emphasized, with ~ 8 kHz rate out of available 15 kHz.

The remaining 5 kHz is available for jet triggers.

Process	Eff (%)
H (80 GeV) → γ γ	97.4
H (120) → Z Z → e e μμ	76.4*
H (200) → Z Z → e e j j	99.1
p p → t t → e X	88.3
p p → t t → H+X → t X	81.7
SUSY (MLSP = 45, Mspart ~ 300 GeV)	83.0

Signal Efficiency

High efficiency for all channels with e & γ.

Difficult-to-trigger top decay events have high efficiency, enabling studies of associated Higgs production.

*Inclusion of μ trigger → full efficiency

- S. Dasu

Nuclear Sci. U. Wisconsin

May, 1997

L3

At high luminosity, the physics bandwidth can be broken down as follows:

photons/diphotons	5 Hz
leptons/dileptons	10 Hz
taus	10 Hz
other (including jets/met)	20 Hz

This categorization takes account of single/multiple particle thresholds. The chosen thresholds allow efficient coverage of all the physics topics of interest. The various physics thresholds can be summarized as follows:

Photons (10 Hz)
- 1 gamma, Et 65 GeV
- 2 gamma's, ET 20 GeV

Leptons (10 Hz)
- 1 e or mu, Pt 70 GeV
- 2 e's or mu's, Pt 20 GeV

Tau's (10 Hz)

- Tau + e or mu Et, 25 GeV
- 2 tau's, Et 35 GeV

Combinations, jets, MET (20 Hz)

- 2 jets, Et 500 GeV
- MET, Et 200 GeV
- multi jets
- multi-jets and MET
- e,mu and multijets
- b jets in combination with e, mu, multijets

Together

High Luminosity							
old L1 Trigger table with old L1 hardware design (no HF in MET trigger, tower-over-threshold jet trigger, no tau trigger)							
Level 1 (from Sridhara Dasu)					**Level 3 (from Jim Virdee)**		
	rate (kHz)					trigger number	rate (Hz)
	the following sums to 20 hz out of level 3 [1]						
1e>25 [2]	6.84				1 gamma>65	1	
(95% eff pt 38 Gev)					1 e >70	2	
2e>12	1.45				2 gammas>20	3	
(95 % eff pt 18 GeV)					2 e's > 20	4	
	the rest sums to 30 hz out of level 3, with 10 hz for the tau triggers [1]						
Sum Et>400	0.48						
MET>80	1.29				MET>200	6	<1 Hz [3]
(95% eff pt 200 GeV)							
1j>100	2.06						
(95% eff pt 200 GeV)							
2j>60	2.17				2 tau's > 35	7	
(95 % eff pt 120 GeV)					2 jets > 500	8	
3j>30	3.16						
(95% eff pt 60 GeV)							
4j>20	2.96						
(95 % eff pt 40 GeV)							
j>50, e>12	1.35				1 tau>25, 1e>25	9	
(95% 100,18)							
[1] from Virdee							
[2] approximate scaling factors L1->95% efficiency point offline: MET: 2.5(?), jets:2 electrons:1.5(?)							
[3] from Pal Hidas							

Physics

physics with jet/met in trigger				
channel	offline cuts	luminosity needed	trigger old table	new table
W(→lν)H(→bb)	1 e> 20 eta<2.5, MET>20, 2 and only 2 jets with et>25 eta<2.5 and they are btagged, no additional jet et>25 eta<4.5		no trigger	6
tt(→lν+X)H(→bb)	1e>20 eta<2.5, MET>20, 6 jets et>25 eta<2.5, 4 b tag jets		no trigger	7
h,H,A→ττ→l+h+X (+ tag jets?)	1 e>15 eta<2.5, 1 tau-jet>40 eta<2.5, 60<delta_phi<175<met>20 (+ 2 beam jets et>25, eta>2?)		no trigger	8
h,H,A→ττ→h+h+X (tag jets?)	2 tau jets et>60 eta<2.5, MET>40(+ 2 beam jets et>25, eta>2)		7,9 (not good)	9
H→ZZ→llν	2 e's>20 (marginal for 2 e trigger), pt(ll)>60, MET>100, 1 beam jet e>1 TeV eta>2		4 (4 is marginal)	4
qqH→WW+ tag jets →lνjetjet+ tag jets	1 et>50, MET>150, 2 central jets Et>40 eta<3, 2 tag jets e>400 et>20 eta>2.5		2(not good)	10
slepton	2 e's>20 (marginal for 2 e trigger), MET>50, no jet with et>25 eta<3.5, delta_phi(MET, pt(ll))>120)		4 (marginal)	4
squark/gluino, rp conserving	2 jets et>40 eta<3, MET>100, 1 e et>20		6,8 (not good)	11
squark/gluino, rp violating	2e et>10, 2 jets et>30 eta<3		4 (not good)	12
ttbar (lν+X)	1e et>20 eta<2.5, 2 bjet et>25 eta<2.5, 2j et>25 eta>2, MET>20		no trigger	7
single top	1e et>20 eta<2.5, 1 bj et>25 eta<2.5, 1 j et>25 eta>2, Met>20		no trigger	6

Comments

Obviously bad match, but this is not suprizing….

Especially, lepton+multijet triggers are important...

A “better” trigger table?

trial table (with new L1 hardware)							
Level 1					**Level 3**		
	rate (kHz)					trigger number	rate (Hz)
1e>40					1 gamma>65	1	
(95% eff point 60 GeV?)					1 e >70	2	
2e>12	1.45				2 gammas>20	3	
(95% eff point 18 Gev?)					2 e's > 20	4	
95% efficiency points in parathesis							
1e>13 (20), 2 jets>17 (20) eta<2.5,						6	
no jet et>50 for eta>2.5							
1e>13 (20), 4 jets>17 (20) eta<2.5						7	
1e>10 (15), 1 taujet>33 (40) eta<2.5,						8	
2 beam jets et>20							
2 tau jets >50 (60)						9	
2 beam jets et>20							
1e>33 (50), 2 jets et>33 (40) eta<2.5						10	
2 jets et>33 (20), MET>50						11	
2e et>7, 2 jet et>25 (30)						12	

Comments

1) only tried to play with L1 so far

2) 1e>25 (38 95% eff pt) L1 trigger does not seem to be needed, as no physics analysis has an e>40 cut… I've moved this up to 1e>40 (60 95% eff pt) to match Virdee's 1gamma>65 trigger (though, still, no obvious physics need, will need prescaled version with lower et cut for efficiencies...)

3) old 2e trigger well-matched to Virdee's L3 and to physics

4) obviously, will need looser prescaled versions of these triggers for calibrations and backgrounds

5) need rates for these. Some look hard (6, 7, 11, 12) (may have too large rate?)

6) beam jets may be required in 2 triggers

7) jet veto in eta>2.5 region required in trigger 6

8) low et jet trigger in L1 very important (6,7,12) Is this do-able?

9) jet counting separatly in eta<2.5, eta>2.5 region

10) no need for "pure" MET cut at L1 (except for zoo trigger, which can have high thres?)

11) no need for pure 1 jet trigger at L1 (except prescaled version for efficiencies)

Comments

12) 3 and 4 jet triggers also not needed (I don't really believe this…)

13) I doubt is sumet is a needed/good trigger

14) MET only needed in trigger 11

Obviously, it would be just as silly to take this table seriously as it was to take Sridhara's and Virdee's… still, gives you someplace to start to think...