Triggers at 2E32 for: Associated Higgs Production

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- Lepton Trigger Synopsis

    Merit?

- Inclusive Level 1 Calorimeter Triggers

    Rates and Performance

- Level 2: Now what?

    Rejection requirements

    STT Assumptions

- Summary:

Level 1 Trigger?

- Lepton based triggering:

  Current single lepton triggers are "fully" efficient at roughly 20-23 GeV

  Inadequate for $W \to \tau$ final states

  Increased reliance on tracking places an upperlimit on efficieny $\times$ acceptance for single leptons

- Use of lepton plus "jet" triggers help but...

  Recent HSS study estimated that muon based triggers have a "merit" of 0.86

  electron based have merit of 0.95

  This assumes 100% efficiency for stricter Level3 requirements that will be necessary to control the rates

- Need an addtional complemetary trigger

Level 1 Trigger?

- I will presume the the following Level 1 Psuedo-Term

  CJT(5,3) or

  CJT(4,3) CJT(3,4) CJT(1,5) or

  CJT(4,3) CJT(2,4) CJT(1,7) or

  CJT(4,3) CJT(2,7) or

  CJT(4,4) or

  CJT(3,4) CJT(2,5) CJT(1,7) or

  CJT(3,5)

  For η coverage to 2.4 and from Zero-Bias data
  the Level 1 rate is 131 Hz at 20E30

- Multiple Interactions

  The effect was estimated by decreasing thresholds
  by 1 ADC count (250 MeV)
  250 MeV is the expected average energy per tower
  for 8 min bias interactions.
  Rates were estimated by folding the poisson distributed
  # of interactions assuming a linear interpolation
  between the rates between 0 and 8 interactions
  Estimated rate at 2E32 is 1.7 kHz

Level 1 Jet Based Trigger

- All channels share the CJT_OR Level 1 condition

Jet Based Level 1 Trigger Efficiency	
Channel	Efficiency
$\mathrm{h}^0\mathrm{W}^\pm \rightarrow b\bar{b}\, e^\pm\nu$	97.8%
$\mathrm{h}^0\mathrm{W}^\pm \rightarrow b\bar{b}\, \mu^\pm\nu$	91.9%
$\mathrm{h}^0\mathrm{W}^\pm \rightarrow b\bar{b}\, \tau^\pm\nu$	94.0%
$\mathrm{h}^0\mathrm{Z}^0 \rightarrow b\bar{b}\, ee$	99.4%
$\mathrm{h}^0\mathrm{Z}^0 \rightarrow b\bar{b}\, \mu\mu$	95.6%
$\mathrm{h}^0\mathrm{Z}^0 \rightarrow b\bar{b}\, \nu\bar{\nu}$	95.6%
$\mathrm{h}^0\mathrm{W}^\pm \rightarrow \tau\tau\, jet\, jet$	99.0%
$\mathrm{h}^0\mathrm{Z}^0 \rightarrow \tau\tau\, jet\, jet$	99.5%

- Effects of dead towers not included

  likely overestimated by 5-10% (Haas)

  Can be slightly improved by considering CEM_OR

- Note the inclusion of

  $\mathrm{h}^0\mathrm{W}^\pm \rightarrow b\bar{b}\, \tau^\pm\nu$

  $\mathrm{h}^0\mathrm{W}^\pm \rightarrow \tau\tau\, jet\, jet$

  $\mathrm{h}^0\mathrm{Z}^0 \rightarrow \tau\tau\, jet\, jet$

Level 2 Jet Based Trigger

- Only consider events passing CJT_OR
- Simulation of Level 2 STT:

  Assume performance of figure 83 or TDR

  3 different operating points: Tight, Loose, Medium

  Ignore any kinematic effects in b-tag
- Kinematic criteria:

  Use combinations of object based event energy flow

  H_T: *scalar sum of L2 "jet"* E_T

  $\not{H}_T$: *modulus of vector* H_T

  H_T^A: *Sum of* H_T *and* $\not{H}_T$

  Can also require lower p_T *lepton*
- Why these criteria?

  QCD jet Xsec at 30 GeV gives ~ 400 *Hz at 2E32*

  $\Longrightarrow$ *Pointless to cut on jet* E_T

  Final state has $\hat{s}$ *of* $\gtrsim 200\ GeV$ vs

  $\sim 60\ GeV$ *for QCD background*

- The L2 Menu:

  10 triggers for 5 (7) channels

  Simple and economical

1. L2HTA(50) L2STT(tight);
2. L2MHT(10) L2STT(tight);
3. L2MHT(20) L2STT(loose);
4. L2HTA(50) L2EM(1,8, $f > 0.85$) L2STT(med);
5. L2HTA(50) L2MU(1,ls,0) L2STT(med);
6. L2HTA(60) L2EM(2,8, $f > 0.85$);
7. L2HTA(60) L2MU(1,med,0);
8. L2HTA(40) L2MU(2,ls,0);
9. L2MHT(30);
10. L2MHT(15) L2MU(1,ls,0).

Level 2 Jet Based Trigger: Rejection

Level 2 Rejection for QCD Background		
Level 2 Filter	Rej.	Rate(Hz)
L2HTA(50) L2STT(tght)	20.6	77
L2MHT(10) L2STT(tght)	24.5	65
L2MHT(20) L2STT(ls)	9.1	175
L2HTA(50) L2EM(1,8, $f > 0.85$) L2STT(med)	17.5	90
L2HTA(50) L2MU(1,ls,0) L2STT(med)	26.4	60
L2HTA(60) L2EM(2,8, $f > 0.85$)	16.4	97
L2HTA(60) L2MU(1,med,0)	32.4	48
L2HTA(40) L2MU(2,ls,0)	11.9	132
L2MHT(30)	11.7	135
L2MHT(15) L2MU(1,ls,0)	6.9	228
Total	2.69	630

- Note that despite excellent individual rejection that the *total* rate is only modestly reduced

Level 2 Efficiency for Wh Production			
Level 2 Filter	$\mu\nu b\bar{b}$	$e\nu b\bar{b}$	$\tau\nu b\bar{b}$
L2HTA(50) L2STT(tght)	0.59	0.60	0.59
L2MHT(10) L2STT(tght)	0.58	0.57	0.55
L2MHT(20) L2STT(ls)	0.73	0.70	0.63
L2HTA(50) L2EM(1,8, $f > 0.85$) L2STT(med)	-	0.66	0.43
L2HTA(50) L2MU(1,ls,0) L2STT(med)	0.65	0.33	0.38
L2HTA(60) L2EM(2,8, $f > 0.85$)	-	-	-
L2HTA(60) L2MU(1,med,0)	0.71	0.18	0.23
L2HTA(40) L2MU(2,ls,0)	0.48	-	0.25
L2MHT(30)	0.69	0.63	0.54
L2MHT(15) L2MU(1,ls,0)	0.82	-	0.47
Total	0.98	0.97	0.96

Level 2 Jet Based Trigger: Efficiency

Level 2 Efficiency for Zh Production			
Level 2 Filter	$\nu\nu b\bar{b}$	$eeb\bar{b}$	$\mu\mu b\bar{b}$
L2HTA(50) L2STT(tght)	0.59	0.60	0.58
L2MHT(10) L2STT(tght)	0.59	-	0.57
L2MHT(20) L2STT(ls)	0.73	-	0.72
L2HTA(50) L2EM(1,8, $f > 0.85$) L2STT(med)	-	0.69	-
L2HTA(50) L2MU(1,ls,0) L2STT(med)	0.32	0.33	0.67
L2HTA(60) L2EM(2,8, $f > 0.85$)	-	0.86	-
L2HTA(60) L2MU(1,med,0)	0.18	0.18	0.90
L2HTA(40) L2MU(2,ls,0)	0.16	-	0.83
L2MHT(30)	0.71	-	0.70
L2MHT(15) L2MU(1,ls,0)	0.36	-	0.89
Total	0.94	0.98	0.99

Summary

L1 and L2 Jet Based Trigger Efficiency			
Channel	Level 1	Level 2	Total
$h^0W^\pm \to b\bar{b}\, e^\pm\nu$	0.978	0.97	0.95
$h^0W^\pm \to b\bar{b}\, \mu^\pm\nu$	0.919	0.98	0.90
$h^0W^\pm \to b\bar{b}\, \tau^\pm\nu$	0.940	0.96	0.90
$h^0Z^0 \to b\bar{b}\, ee$	0.994	0.98	0.97
$h^0Z^0 \to b\bar{b}\, \mu\mu$	0.956	0.99	0.95
$h^0Z^0 \to b\bar{b}\, \nu\bar{\nu}$	0.956	0.94	0.90

Summary of Trigger Rates at 2E32			
Group	Level 1	Level 2	Merit
Muon based	880	300	0.86
Electron based	1050	260	0.95
Jet based	1700	6300	~ 1
Totals	2800	1050	~ 1

Summary

- It has been shown that triggering on associated production at high luminosities with essentially 100% efficiency is possible
- It should be noted that at lower luminosities is is possible to achieve the same performance without STT (work in progress)
- Although it is too late for Trigger List 12
  getting the looser version into the post-shutdown list
  is a desirable and achievable goal