VBF H(invisible)

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VBF H(invisible)

- H->invisible search is inspired by dark matter
- 2012 result (HIG-13-013) most sensitive direct search for this decay mode

- 2012 offline selection
  - Two jets p_T > 50 GeV, fwd/bkwd
  - Δη(jj) > 4.2, M(jj) > 1100 GeV, Δϕ<1.0
  - MET > 130 GeV

- 2012 Trigger
  - L1_ETM40
  - HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v*
    - Dijet p_T > 40 GeV, fwd/bkwd, Δη > 3.5, M_{jj} > 800 GeV
    - METNoMu > 65 GeV
  - Efficiency measured in data with single mu triggers

- Efficiency wrt total signal cross section (for m_H=125, BF=100%)
  - L1 : ~47%, HLT : ~9%

Study Details

- CMSSW 7_2_0

- Samples : Fall13 TSG 62X, PU40 bx25 (L_{inst} = 1.4E34)
  - L1 rates : neutrino gun
  - HLT rate : binned QCD
  - Signal eff : VBF H125->invisible

- L1
  - Re-emulation of stage 1
  - L1Menu_Collisions2015_25ns_v1/L1T_Scales_20101224/Imp0

- HLT
  - Setup : /dev/CMSSW_7_2_0/GRun/V14
  - Paths : /users/jbrooke/vbfHinv/dev/V10
  - (Jet/MET reco and MET noise cleaning copied from master above)

L1 Seeds for 2015

- Starting point is lowest unprescaled MET trigger
  - L1_ETM70
- Try to increase signal yield by adding jet requirements
- Additional rate wrt existing L1 menu, still to be calculated

Increase wrt L1_ETM70 ↓

	Ind rate	Extra rate	Ind eff	Extra yield
ETM70	7kHz	-	28%	-
Dijet30 + fwd/bkwd + $\Delta\eta(jj)>3.5$ + Jet96	4.6 kHz	?	15%	21%
Dijet30 + fwd/bkwd + $\Delta\eta(jj)>3.5$ + ETM50	5.0kHz	?	14%	14%
ETM60 + jet veto ($p_T>40$ GeV, $\Delta\phi<1.0$) [1]	5.5kHz	?	14%	11%
HTT70 + MHT/HTT>0.7 [2]	9 kHz	?	22%	11%

1 - proposed by Z(vv)H(bb)
2 - proposed by SUSY

HLT 2015

- Strategy
  - PFMET170 will provide high MET sample
  - Obtain medium MET sample by adding jet requirements
  - Control trigger obtains very low MET sample for measuring trigger turn-ons

- Paths include
  - Calo MET noise cleaning a la PFMET170
  - Calo MET > 80 GeV
  - Calo jet requirements : dijet p_T>40 GeV, $\Delta\eta(jj) > 2.5$, $M_{jj} > 500$ GeV

Signal Triggers	L1 seed	Rate	Eff.	Total eff
HLT_PFMET170_NoiseCleaned	L1_ETM70	?	9%	9%
HLT_DiPFJetVBF40_DEta3p5_MJJ600_PFMETNoMu140	L1_ETM70	4.7 Hz	?	10.5%
HLT_DiPFJetVBF60-40_DEta3p5_MJJ600_PFMETNoMu140	L1_ETM70	4.5 Hz	?	10.5%
Control Trigger				
HLT_DiPFJetVBF40_DEta3p5_MJJ600_PFMETNoMu80	L1_ETM50	0.5 Hz	-	-

To Do

- Additional rate/efficiency by including dedicated L1 seeds
- CPU timing

Backup

L1 MET Issues

- 2012 analysis showed significant loss of efficiency in trigger
  - MC signal yield after all cuts = **209 events**
  - MC signal yield after all cuts, *but no trigger* = **247 events**

Trigger loses 15% of potential signal

- Plots below show :
  - Events in signal region, no trigger & Events in signal region, failing trigger
  - Loss of efficiency entirely due to L1 MET cut
  - Tag jet η distribution shows majority of failing events have a jet in HF
  - **L1 MET calculation is configured to use only |η| < 3**