



# VBF H(inv) - Trigger Strategy 2015

J. Pela on behalf of the VBF H(inv) analysis members

# 2012 Trigger



- ▶ We ran a suite of triggers with different thresholds and variations in logic
  - ▶ With the main goal of robustness
- ▶ The trigger used for the signal region was :
- ▶ L1
  - ▶  $\text{MET} > 40 \text{ GeV}$
- ▶ HLT
  - ▶ Di-jet pair :  $p_T > 40 \text{ GeV}$ , fwd/bkwd,  $\Delta\eta > 3.5$ ,  $M_{jj} > 800 \text{ GeV}$
  - ▶  $\text{METNoMu} > 65 \text{ GeV}$
- ▶ Use of METNoMu provides samples of W(mu) and Z(mumu) for background estimation
- ▶ We also ran parked triggers with reduced jet  $p_T$  and  $M_{jj}$  thresholds
  - ▶ Will not replace these in 2015

- ▶ Signal Trigger
  - ▶ *HLT*
    - ▶ As for 2012 with raised thresholds
    - ▶ Some possible additions to minimise threshold increase :
      - ▶ PU jet removal
      - ▶ QCD rejection using  $\Delta\phi(\text{jet}, \text{MET})$
  - ▶ *L1*
    - ▶ Need to add jet conditions to reduce MET threshold
    - ▶ See next slides
- ▶ Control Trigger
  - ▶ One issue from 2012 analysis was stat. uncertainty in trigger efficiency measurement
  - ▶ Anticipate prescaled control trigger for measuring signal trigger efficiency
    - ▶ eg. di-jet + MET (with no VBF conditions)
  - ▶ Need to study requirements : sample size, thresholds, prescale

# Level 1

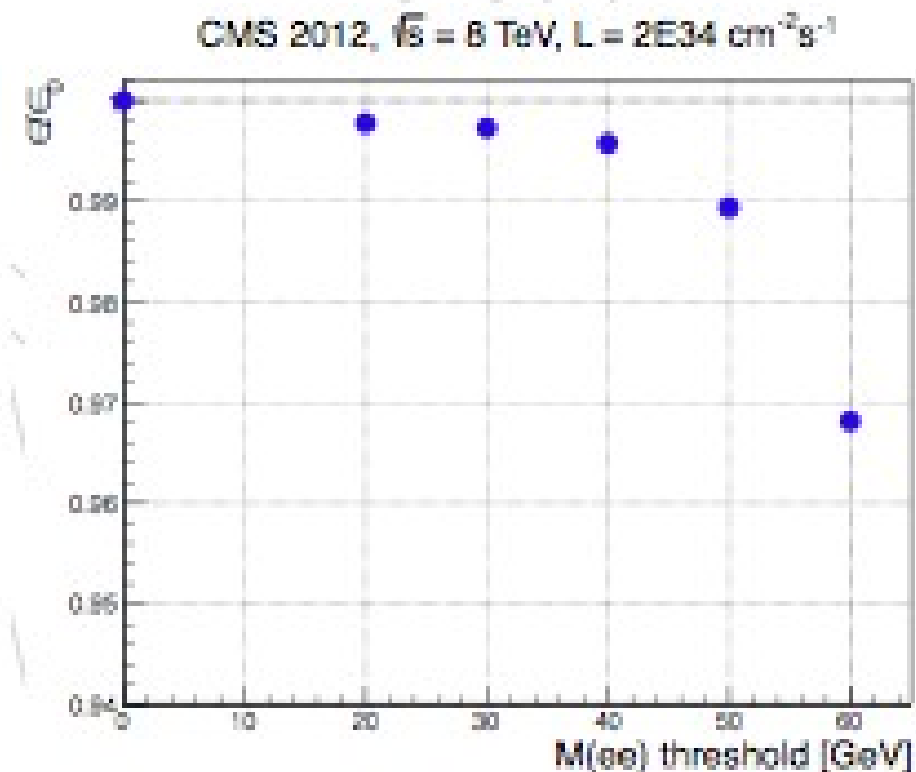
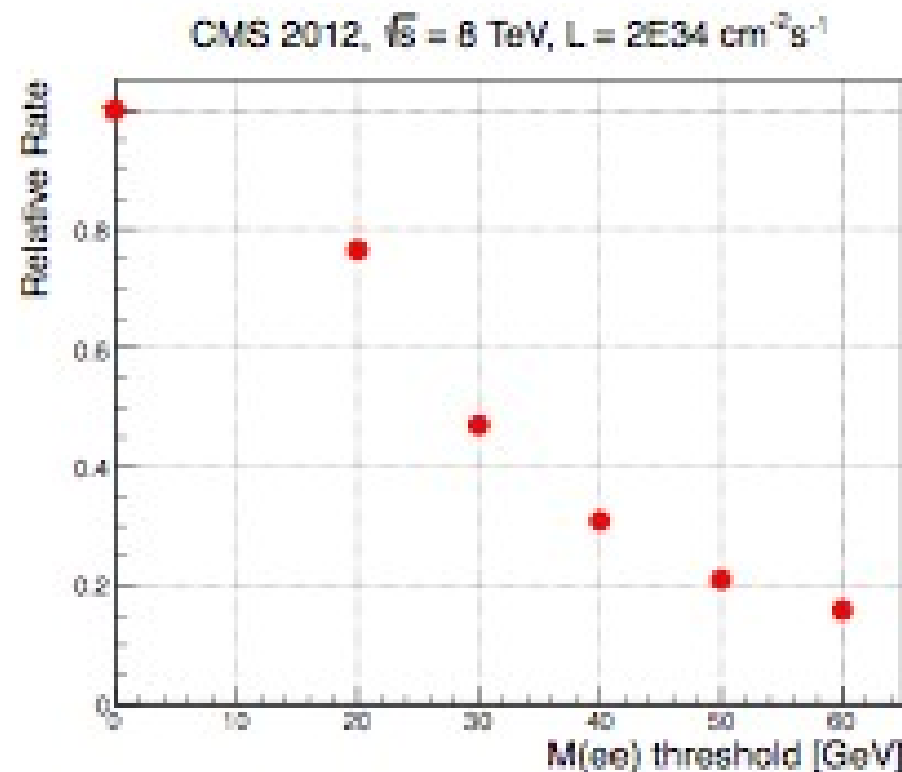


- ▶ 2012 signal trigger seeded by L1\_ETM40
  - ▶ Slow trigger turn-on results in offline threshold of 130 GeV
  - ▶ Anticipate threshold of 70 in 2015 (PU40bx25)
- ▶ Upgrades
  - ▶ L1 will be upgraded during 2015 and 2016, increasing capabilities at each step
  - ▶ Aim to study 1-2 options for each scenario (Legacy, 2015, 2016)
- ▶ Legacy
  - ▶ MET
  - ▶ (Di)jet + MET +  $\Delta\phi(\text{jet}, \text{MET})$  ← VBF selection, may be ineffective due to PU
  - ▶ Dijet + MET +  $\Delta\eta(\text{jet}, \text{jet})$  ? ← QCD rejection
- ▶ Stage 1 (2015)
  - ▶ MHT/HTT
- ▶ Stage 2 (2016)
  - ▶ Dijet + MET + Mjj

# Invariant Mass



- ▶ Full L1 trigger upgrade (2016) will include invariant mass calculation
- ▶ Already shown to be useful in di-EG and di-muon triggers (L1 Upgrade TDR)



- ▶ Past studies (J Pela) have indicated this can be useful for VBF H(invisible)

# Legacy system (baseline )

- ▶ We can define a baseline by just updating the seed of our HLT paths to the lowest unprescaled L1 ETM available trigger.
  - ▶ In the current draft menu this is L1\_ETM70
- ▶ With the help of neutrino gun samples we can calculate VBF H(inv) signal efficiency:

L1+HLT	PU20bx25	PU40bx50	PU40bx25
L1_ETM40 + HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	0.1079	0.1092	0.1168
L1_ETM70 + HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	0.0761	0.0774	0.0841
L1_ETM40 + HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	0.0850	0.0879	0.0920
L1_ETM70 + HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	0.0615	0.0634	0.0677

- ▶ By raising the seed from L1\_ETM40 to L1\_ETM70 we lose ~30% signal efficiency.
  - ▶ This is a tolerable efficiency loss but we aim at improving algorithms both on the L1T and HLT sides
- ▶ We can now calculate the expected pure HLT rates for this paths.

L1+HLT	PU20bx25	PU40bx50	PU40bx25
L1_ETM40 + HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	113.48	179.95	1903.08
L1_ETM70 + HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	21.62	57.78	308.35
L1_ETM40 + HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	78.36	127.12	1087.03
L1_ETM70 + HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	18.91	42.92	263.97

- ▶ HLT pure rates drop significantly to ~20Hz on first scenario
  - ▶ HLT PU subtraction should further lower this rates.
- ▶ At the last PU scenario rates become too high. We can again do the exercise of raising the seed, but at this point we should have in place a better trigger with more options.

# Plan



- ▶ Study L1 seed options Joao
- ▶ Implement the path in HLT ConfDB Jim
- ▶ Run on data / MC
  - ▶ Trigger efficiency
  - ▶ Purity after analyses cuts Jim / Chayanit
  - ▶ Rate estimates
  - ▶ CPU timing measurements
- ▶ Strategy & code for validation of the triggers
  - ▶ how ? if not using DQM, why not ? Expand existing VBF DQM code - Phat
- ▶ Strategy for efficiency estimates from data
  - ▶ which samples will be used ? Single muon +
  - ▶ which other triggers will it rely on ? our own control trigger
- ▶ Aim for baseline triggers & implementation by October TSG Workshop