



Study of the trigger efficiency for the $t\bar{t}\bar{t}$ signal

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- This is basically a **crosscheck** of the number that Huiling got in the past
 - **See what happens after** per-event weight and eleID **bug fixes**
- **Only main difference:** I put some **lower bound** cuts **on lepton** p_T for leptonic triggers
 - As a rough first guess: $p_T^\ell > 30 \text{ GeV}$

Two trigger setups



Trigger
efficiency

F. Lemmi

Trigger
efficiency

- I tried two different trigger setups: **$t\bar{t}H$ ML setup** and **ZhangYu's setup**
- **$t\bar{t}H$ ML setup**
 - **$1\tau 0L$: OR of multijet triggers**
 - $1\tau 1L$: OR of single lepton and lepton+tau triggers
 - $1\tau 2L$: OR of single lepton, double lepton and $ele+\mu$ triggers
 - $1\tau 3L$: same of $1\tau 2L$ + OR of trilepton triggers
 - $2\tau 0L$: OR of double tau triggers
 - $2\tau 1L$: same as $1\tau 1L$
 - $2\tau 2L$: same as $1\tau 2L$
- **ZhangYu's setup**
 - $1\tau 0L$: OR of multijet triggers
 - $1\tau 1L$: OR of multijet triggers
 - $1\tau 2L$: OR of multijet triggers
 - $1\tau 3L$: OR of multijet triggers
 - $2\tau 0L$: OR of multijet triggers
 - $2\tau 1L$: OR of multijet triggers
 - $2\tau 2L$: OR of multijet triggers

Details about the triggers are in [▶ backup](#)



$$\epsilon^i = \frac{N_{\text{trig}}^i}{N^i}$$

where N^i is the number of events falling in category i , after possibly some lepton pt requirements, and N_{trig}^i is the number of events also passing trigger requirements.

More precisely, N^i and N_{trig}^i are actually the sum of weights ($t\bar{t}\bar{t}$ is a weighted sample)



- $t\bar{t}H$ ML setup**

	1tau0L	1tau1L	1tau2L	1tau3L	2tau0L	2tau1L	2tau2L
num	498.168	263.281	88.1315	6.76591	9.53775	8.83934	1.87699
den	505.174	333.8	90.7069	6.76591	26.889	11.6548	1.98612
trigEff	0.986132	0.788741	0.971607	1	0.354708	0.758427	0.945055

- ZhangYu's setup**

	1tau0L	1tau1L	1tau2L	1tau3L	2tau0L	2tau1L	2tau2L
num	498.168	413.485	110.481	7.70441	25.9724	12.7461	1.94247
den	505.174	425.052	118.316	8.14092	26.889	14.0338	2.2262
trigEff	0.986132	0.972786	0.933776	0.946381	0.965909	0.908243	0.872549



- It seems we can in general **achieve pretty high trigger efficiencies** (with some exceptions)
 - On average multijet triggers outperform lepton triggers
- **If we combine both the setups** taking the best efficiency for each category, the **best performance** would be in $1\tau 3L$ (**100% eff**) and the **worst** in $2\tau 1L$ (**91% eff**)
- I believe **ZhangYu's** setup has a **major advantage**: **way easier to compute data/MC scale factors**
 - I still do not fully understand how this is done in $t\bar{t}H$ ML setup...
 - Many ORs of triggers from different PDs
 - Many triggers for which $L_{\text{effective}} \neq L_{2016}$



Backup slides



- **Multijet triggers**

- HLT_PFHT450_SixJet40_BTagCSV_p056
- HLT_PFHT400_SixJet30_DoubleBTagCSV_p056

- **Single lepton triggers**

- HLT_Ele25_eta2p1_WPTight_Gsf
- HLT_Ele27_WPTight_Gsf
- HLT_Ele27_eta2p1_WPLoose_Gsf
- HLT_IsoMu22
- HLT_IsoTkMu22
- HLT_IsoMu22_eta2p1
- HLT_IsoTkMu22_eta2p1
- HLT_IsoMu24
- HLT_IsoTkMu24



- **Lepton+tau triggers**

- HLT_Ele24_eta2p1_WPLoose_Gsf_LooseIsoPFTau20
- HLT_Ele24_eta2p1_WPLoose_Gsf_LooseIsoPFTau20_SingleL1
- HLT_Ele24_eta2p1_WPLoose_Gsf_LooseIsoPFTau30
- HLT_IsoMu19_eta2p1_LooseIsoPFTau20_SingleL1

- **Double lepton triggers**

- HLT_Ele23_Ele12_CaloIdL_TrackIdL_IsoVL_DZ
- HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL
- HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL_DZ
- HLT_Mu17_TrkIsoVVL_TkMu8_TrkIsoVVL
- HLT_Mu17_TrkIsoVVL_TkMu8_TrkIsoVVL_DZ



- **Electron+muon triggers**

- HLT_Mu8_TrkIsoVVL_Ele23_CaloIdL_TrackIdL_IsoVL
- HLT_Mu8_TrkIsoVVL_Ele23_CaloIdL_TrackIdL_IsoVL_DZ
- HLT_Mu23_TrkIsoVVL_Ele8_CaloIdL_TrackIdL_IsoVL

- **Trilepton triggers**

- HLT_Ele16_Ele12_Ele8_CaloIdL_TrackIdL
- HLT_TripleMu_12_10_5
- HLT_Mu8_DiEle12_CaloIdL_TrackIdL
- HLT_DiMu9_Ele9_CaloIdL_TrackIdL

- **Double tau triggers**

- HLT_DoubleMediumIsoPFTau35_Trk1_eta2p1_Reg
- HLT_DoubleMediumCombinedIsoPFTau35_Trk1_eta2p1_Reg