Trigger studies update

$t\bar{t}H$ Multilepton Meeting

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Overview

See proposed triggers/categories here

Reminder of general strategy

- Single- and double-lep triggers in 2lss categories
- Single-, double-, and triple-lep triggers in 3l, 4l categories. No quad-lep triggers.
- Single-lep triggers:
  - Extend pt range of non-leading leptons down to 10 GeV
  - OR'd with double-, triple-lep triggers in overlapping regions to increase efficiency.

3l triggers

Together, these cover all possible 3l combinations

- HLT_DiMu9_Ele9_CaloIdL_TrackIdL
- HLT_Mu8_DiEle12_CaloIdL_TrackIdL
- HLT_TripleMu_12_10_5
- HLT_Ele16_Ele12_Ele8_CaloIdL_TrackIdL

Proposal for 3l p_T Regions

3l order by p_T	3l trigger	2l trigger	1l trigger
$\mu\mu\mu$	>(20, 15, 10)	>(20, 10, 10)	>(25, 10, 10)
eee	>(20, 15, 10)	>(20, 15, 10)	>(25, 10, 10)
$\mu\mu e$	>(20, 10, 10)	>(20, 10, 10)	>(25, 10, 10)
$\mu e\mu$	>(20, 10, 10)	>(20, 10, 10)	>(25, 10, 10)
$e\mu\mu$	>(20, 10, 10)	>(20, 10, 10)	>(25, 10, 10)
$ee\mu$	>(20, 15, 10)	>(20, 15, 10)	>(25, 10, 10)
$e\mu e$	>(20, 15, 15)	>(20, 10, 10)	>(25, 10, 10)
μee	>(20, 15, 15)	>(20, 15, 10)	>(25, 10, 10)

Triggers OR'd in regions where they overlap

3l trigger efficiency by event type

3l order by p_T	region	eff. of 3l trigger ONLY (no OR)
$\mu\mu\mu$	>(20, 15, 10)	0.91
eee	>(20, 15, 10)	0.91
$\mu\mu e$	>(20, 10, 10)	0.90
$\mu e\mu$	>(20, 10, 10)	0.90
$e\mu\mu$	>(20, 10, 10)	0.92
$ee\mu$	>(20, 15, 10)	0.92
$e\mu e$	>(20, 15, 15)	0.92
μee	>(20, 15, 15)	0.93

So far looks good; next will check eff. after adding single, double lep triggers / pt regions
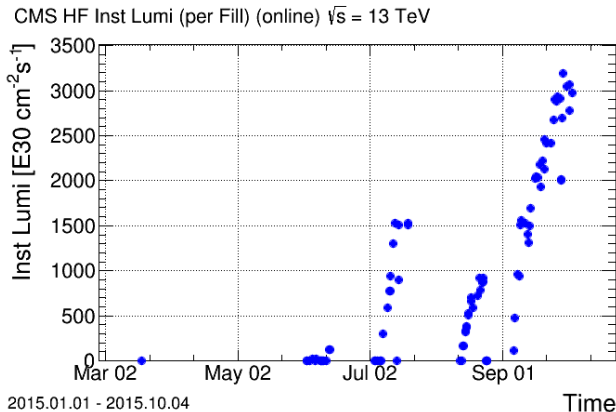
Note on single lep triggers

- HLT_IsoMu20 and HLT_IsoTkMu20 unprescaled triggers are available in MC as well as online. Is there any reason not to use 25 GeV threshold with these triggers?

- For single Ele triggers, propose to use 25 GeV threshold instead of 30 GeV, replacing:
  - HLT_Ele27_WP85_Gsf_v1 → HLT_Ele23_CaloIdL_TrackIdL_IsoVL_v1 in MC
  - HLT_Ele27_WPLoose_Gsf_v2 → HLT_Ele23_WPLoose_Gsf_v2 in data

- In this way, the single-lep threshold can be lowered to 25 GeV for both muons and electrons

HLT_Ele27_WP85_Gsf_v1 in MC and HLT_Ele27_WPLoose_Gsf_v2 in online menu are not identical

- L1 seeds:
  - HLT_Ele27_WP85_Gsf_v1: "L1_SingleEG25"
  - HLT_Ele27_WPLoose_Gsf_v2: "L1_SingleIsoEG20er OR L1_SingleEG20 OR L1_SingleEG25"
- different params in ECAL clustering algo, ECAL iso filter
- different HCAL effective areas, other params. Affects HCAL clustering algo, HCAL iso filter.
- Chi2 fit to Gsf track vars used in HLT_Ele27_WP85_Gsf_v1, but not in HLT_Ele27_WPLoose_Gsf_v2
- differences in dEta, dPhi, other tracker isolation cuts

Not clear that HLT_Ele27_WPXXX triggers are more similar between online and offline menus than lower-threshold ele triggers

Inst Lumi so far this year

CMS HF Inst Lumi (per Fill) (online) $\sqrt{s}$ = 13 TeV

Inst Lumi [E30 cm^{-2}s^{-1}]

2015.01.01 - 2015.10.04

Time

First 2 columns of HLT_Ele23_WPLoose_Gsf are prescaled, but if we do not go higher than $\approx 5 \times 10^{33} cm^{-2}s^{-1}$, this should not be a problem.

Summary

- So far, efficiency of triple lepton triggers looks good. Presumably will only improve after adding single, double lep triggers (will check).
- Would like to take advantange of lower-lumi conditions to use lower-pt single ele trigger
  - Will look at performance of HLT_Ele27_WP85_Gsf_v1 vs. HLT_Ele23_CaloIdL_TrackIdL_IsoVL_v1 in MC – did not have time for today