Trigger Study for ttH, H→bb

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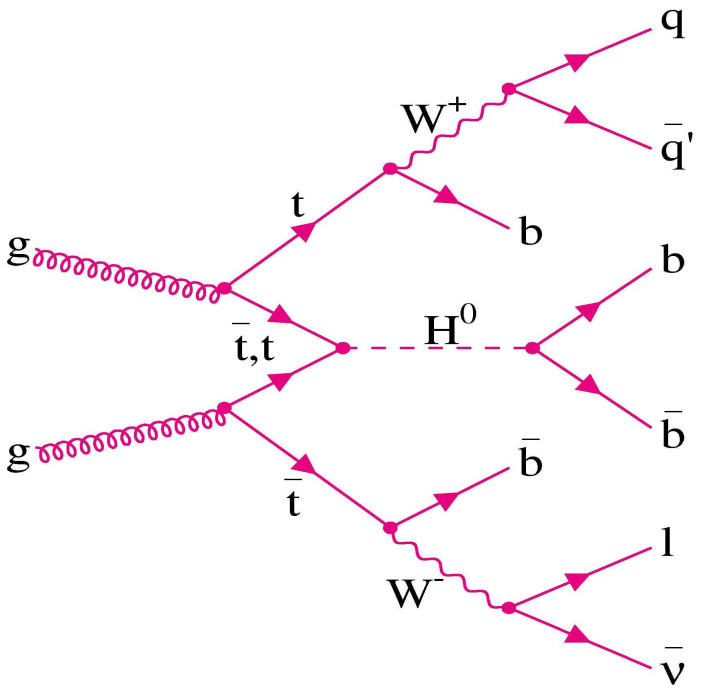
Semileptonic ttH, H→bb channel

- Lepton Preselection:
  - 1 isolated lepton
    - Electrons:
      - author = 1 or 3
      - isEM & 0xFF
      - Etcone20/p_T=0.15
      - p_T >25GeV, |η|<2.5
    - Muons:
      - Author = 1
      - Etcone20/p_T=0.3
      - p_T >20GeV, |η|<2.5
      - D_0vtx ≤ 0.05mm
      - χ^2 < 30
- 6 jets with pt>20 GeV, |eta|<5
  - Of which 4 jets |η|<2.5
  - Soft muon correction and out of cone correction



Final State: 6 jets (of which 4 are b-jets), lepton & missing E_T

https://twiki.cern.ch/twiki/bin/view/Atlas/TtHhbbAnalysisPreselection

Datasets and Efficiency and Caveats in 12.0.6

- Semileptonic ttH dataset (rel. 12.0.6):
  - trig1_misal1_mc12_V1_005870.ttH_poslepnu_jj_bb.recon.AOD.v12000601_tid008657
  - trig1_misal1_mc12_V1_005871.ttH_neglepnu_jj_bb.recon.AOD.v12000601_tid008658

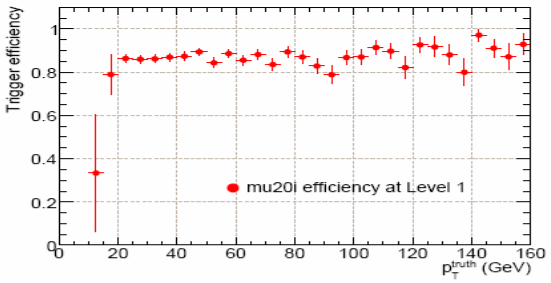
- Efficiencies are caclulated after the preselection:
  - ε = # (pass trigger & preselection) / # (pass preselection)
  - higher statistics after preselection vs final selection
  - cuts after preselection don‘t interfere significantly with trigger efficiency

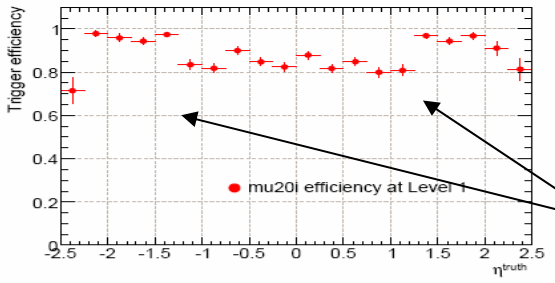
- Studied trigger signatures and caveats in 12.0.6

trigger item	Level 1 (threshold)	Level 2	Eventfilter	comments
e25i	L1_EM25 (18 GeV) EM ring isol = 3 GeV HAD isol = 2 GeV Had ring isol = 2 GeV	L2_e25i	EF_e25i	IDScan used at L2;
e60	L1_EM60 (50 GeV)	L2_e60	EF_e60	IDScan used at L2
mu20i	L1_MU20 (20 GeV)	L2_mu20i	EF_mu20i	no isolation

Trigger Efficiency of mu20(i)

ε vs p_T^{true}

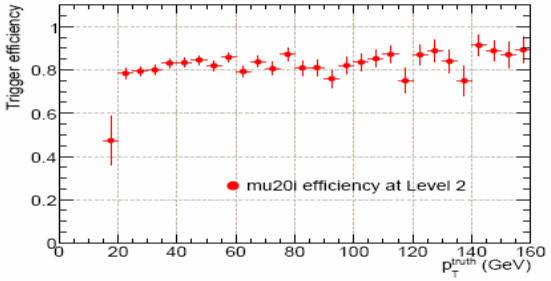


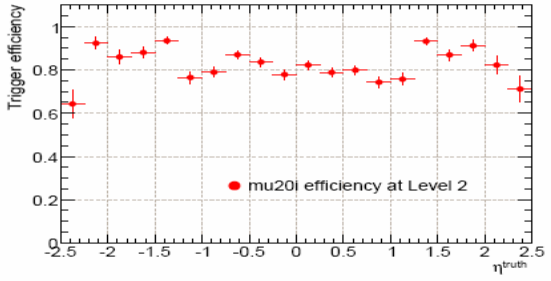


ε vs η^{true}

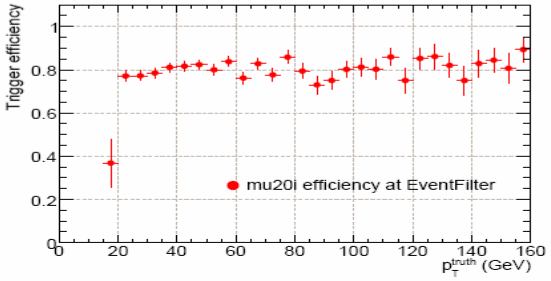
Gaps in muon detector

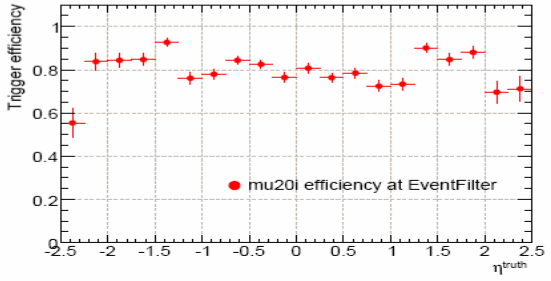
(a) mu20i efficiencies at Level 1.





(b) mu20i efficiencies at Level 2.



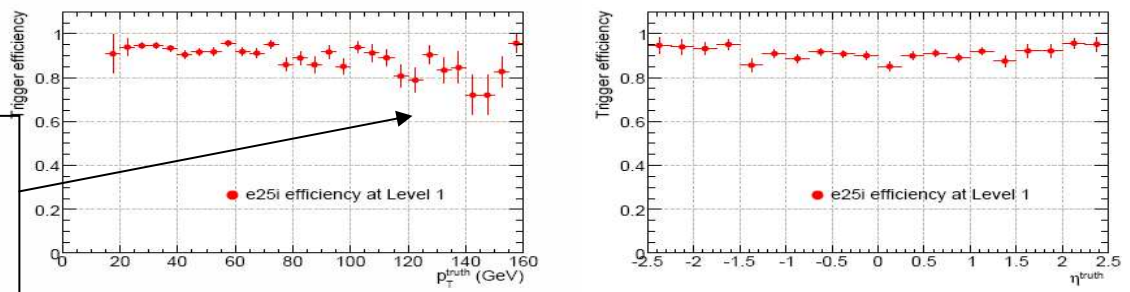


(c) mu20i efficiencies at Eventfilter.

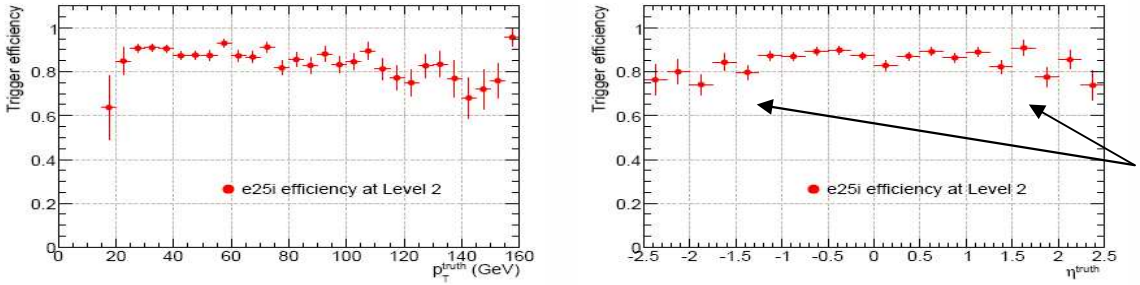
Trigger Efficiency of e25i

ε vs p_T^{true}

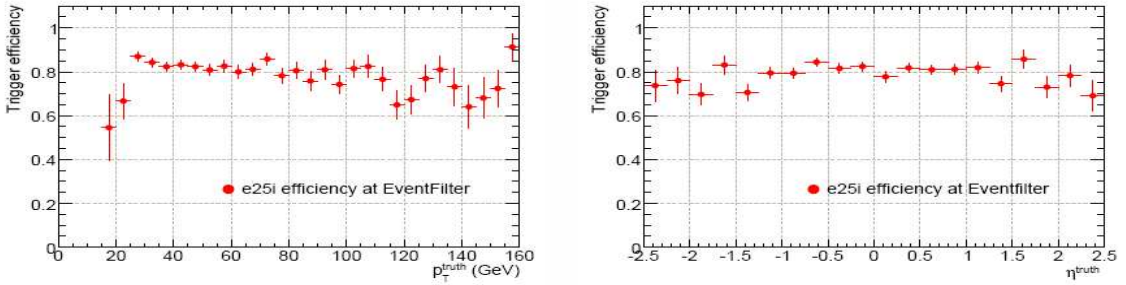
Inefficiency at high p_T due to isolation criteria ($\rightarrow$ e60)



(a) e25i efficiencies at Level 1.



(b) e25i efficiencies at Level 2.



(c) e25i efficiencies at Eventfilter.

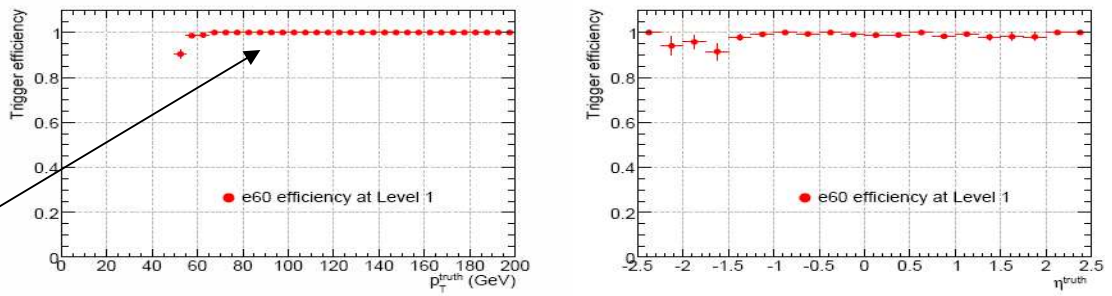
ε vs η^{true}

L2 Spacepoint bug, non flat efficiencies in end cap region

Trigger Efficiency of e60

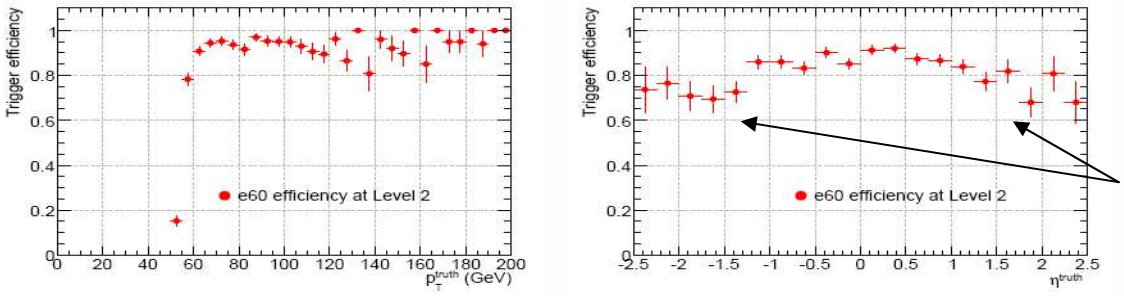
ε vs p_T^{true}

very high eff at L1, only p_T cut applied, no isolation cuts!



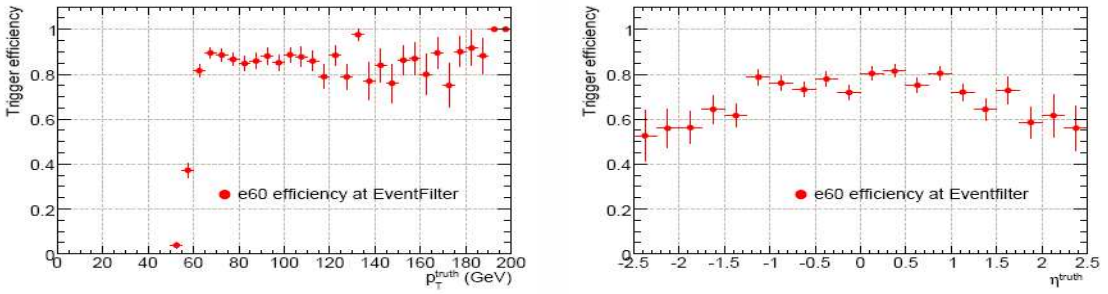
(a) e60 efficiencies at Level 1.

ε vs η^{true}



(b) e60 efficiencies at Level 2.

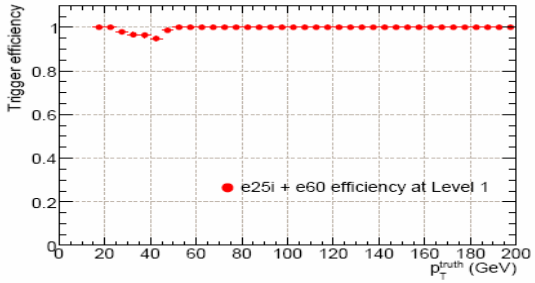
L2 Spacepoint bug

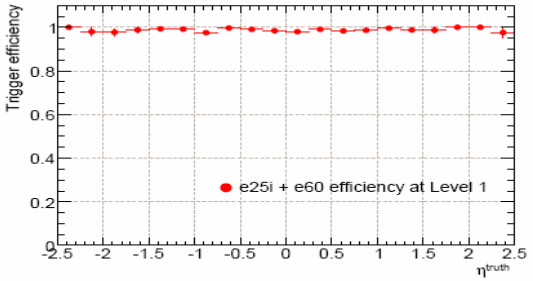


(c) e60 efficiencies at Eventfilter.

Trigger Efficiency of e25i || e60

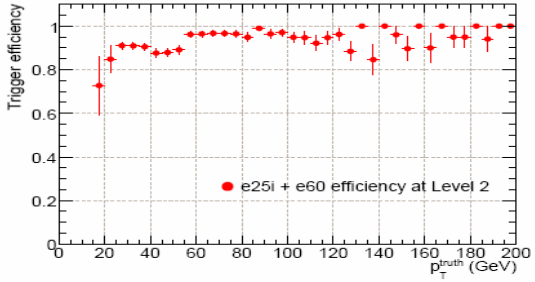
ε vs p_T^{true}

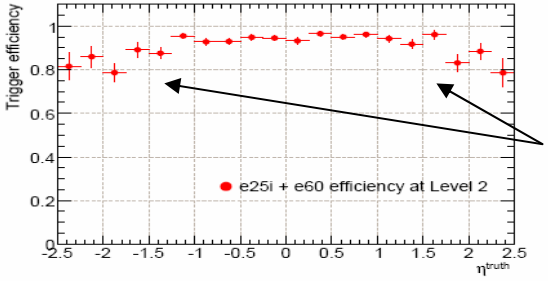




ε vs η^{true}

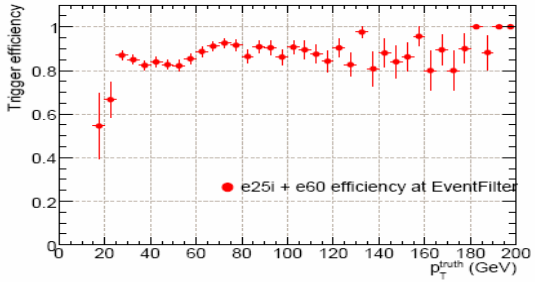
(a) Efficiencies of (e25i or e60) at Level 1.

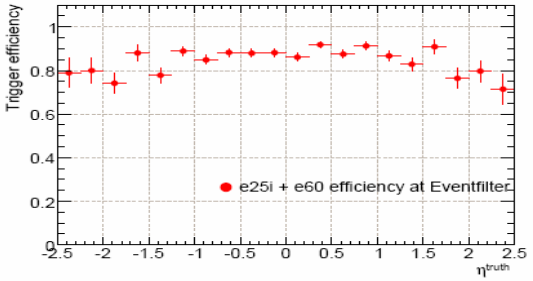




L2 Spacepoint bug

(b) Efficiencies of (e25i or e60) at Level 2.





(c) Efficiencies of (e25i or e60) at Eventfilter.

Efficiencies of Trigger Items

$$\varepsilon(\text{e25i/e60}) = \frac{\text{number of events where electron passed e25i/e60}}{\text{number of events with electron from W (truth information)}}$$

$$\varepsilon(\text{mu20i}) = \frac{\text{number of events where electron passed mu20i}}{\text{number of events with muon from W (truth information)}}$$

After preselection

Trigger level	ε(e25i)	ε(e60)	ε(mu20i)
Level 1	90.0±0.5%	80.8±0.5%	86.9±0.5%
Level 2	85.8±0.6%	51.5±0.8%	82.2±0.6%
Eventfilter	79.3±0.7%	44.3±0.8%	79.9±0.6%

After final selection:

Trigger level	ε(e25i)	ε(e60)	ε(mu20i)
Level 1	91.1±0.6%	78.2±0.5%	86.2±0.6%
Level 2	87.1±0.7%	48.7±1%	81.5±0.7%
Eventfilter	80.4±0.8%	41.4±1%	79.5±0.7%

Final selection cuts have no significant impact on Trigger efficiencies

Efficiencies of Trigger Items

$$\varepsilon(\text{e25i or e60}) = \frac{\text{number of events where electron passed e25i or e60}}{\text{number of events with lepton from W (truth information)}}$$

$$\varepsilon(\text{e25i or mu20i}) = \frac{\text{number of events where lepton passed e25i or mu20i}}{\text{number of events with lepton from W (truth information)}}$$

$$\varepsilon(\text{e25i or e60 or mu20i0}) = \frac{\text{number of events where lepton passed e25i or e60 or mu20i}}{\text{number of events with lepton from W (truth information)}}$$

After preselection:

Trigger level	ε(e25i or e60)	ε(e25i or mu20i)	ε(e25i or e60 or mu20i)
Level 1	45.4 ± 0.5 %	88.3±0.4%	92.4±0.3%
Level 2	42.7 ± 0.5 %	83.4±0.4%	87.0±0.4%
Eventfilter	39.6 ± 0.5 %	79.7±0.4%	82.7±0.4%

After final selection:

Trigger level	ε(e25iore60)	ε(e25iormu20i)	ε(e25iore60ormu20i)
Level 1	45.9 ± 0.5 %	88.5±0.4%	91.9±0.4%
Level 2	43.3 ± 0.5 %	84.1±0.5%	86.7±0.5%
Eventfilter	41.1 ± 0.5 %	79.9±0.5%	82.4±0.5%

Final selection cuts have no significant impact on Trigger efficiencies

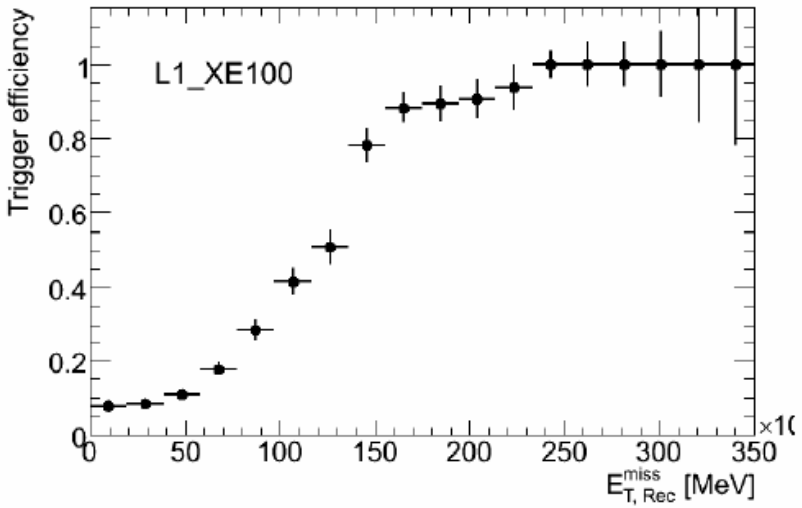
Missing E_T trigger

Ricardo Goncalo

Works in release 12 only for L1

Had a very quick look at ttH semileptonic 5870 (positive lepton, 2500 events) and 5071 (negative lepton, 3500 events) AODs:

Events analyzed: 6000
Events preselected: 2878
Events preselected by:
electron pass = 1812
muon pass = 2301
jets pass = 4253



Level	e25i	e60	mu20	xe100	All (no XE)	All (with XE)
L1	52%	67%	52%	23%	97%	98%
L2	44%	27%	45%		89%	92%
EF	41%	23%	43%		84%	88%

Jet Trigger

Fabrizio Parodi

	Fabrizio	Catrin
4j50	49%	49.0%
3j65	50%	50.3%
2j120	25%	24.99%
1j160	29%	29.4%
Lep	80%	80.5% (83.3% with e60)
Jet	-----	64.1%
Lep+jet	93%	93.2% (93.5% with e60)

- Overlap in efficiencies for lepton and jet triggers
- Although single lepton trigger is more robust and less affected by systematics, summing up lepton & jet triggers more efficient

Summary

- Pre ttH CSC note written
- For final CSC note:
  - Move to release 13
  - Plots with reconstructed higgs mass plots for signal and background samples for:
    - checking eventual bias of online selection
    - Analysis dependence of selection thresholds
  - Include missing E_T trigger L1_xe100 in study
  - Look at jet trigger for combination with lepton trigger