Trigger studes (fourth part)

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Trigger efficiency studies

- **Goal**: compute **trigger efficiency as a function of H_T**
- **Compare** results for **data and MC**, **extract** trigger **SF** if needed
- Trigger efficiency definition:

$$\varepsilon(H_T) = \frac{\mathrm{N}_{\mathrm{trig+presel}}}{\mathrm{N}_{\mathrm{presel}}}(H_T)$$

- **N.B.**: **in data, we never have all the events that pass the offline preselection**
- In data, events are **always** collected with a trigger
  - In other words, denominator meaningless for data

Trigger efficiency studies

- We need an **unbiased sample of events**
- This should be **collected with a reference trigger** with looser and (if possible) orthogonal criteria
- Then the efficiency definition becomes

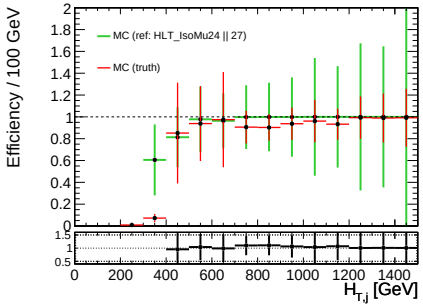
$$\varepsilon(H_T) = \frac{\mathrm{N}_{\mathrm{trig+presel+reference}}}{\mathrm{N}_{\mathrm{presel+referece}}}(H_T)$$

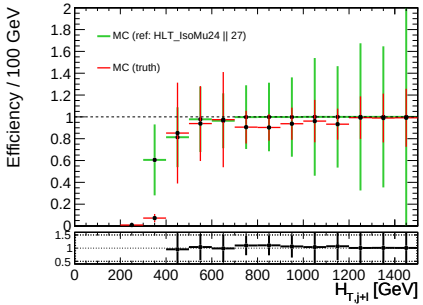
  which makes sense for data as well
- Obviously the **reference should be unbiased**, i.e., should not change MC efficiency distribution

Our current choices

- **Choice of signal triggers**
  - `HLT_PFHT450_SixJet40_BTagCSV_p056` **OR** `HLT_PFHT400_SixJet30_DoubleBTagCSV_p056`
- **Choice of reference triggers**
  - `HLT_IsoMu24` **OR** `HLT_IsoMu27`
- These are the same choices of 4tops FH and $t\bar{t}H(bb)$
- **Study efficiency as a function of HT(jets) and HT(jets+leptons)**
- **Issue**: couldn't use TEfficiency

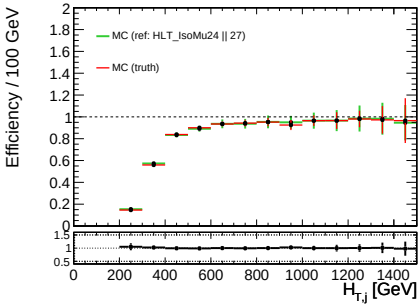
1τ 0L

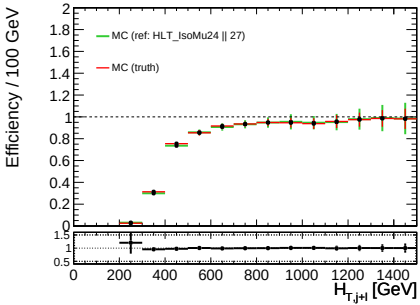




- Left: as a function of HT(jets); right: as a function of HT(jets+leptons)

1τ 1L





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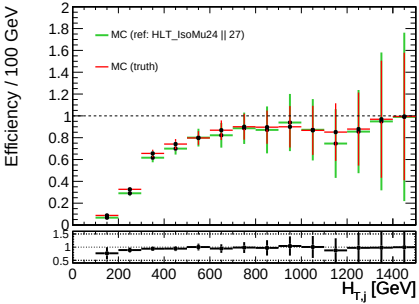
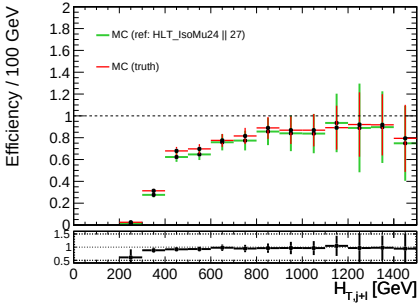
1τ 2L





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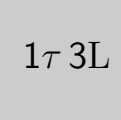

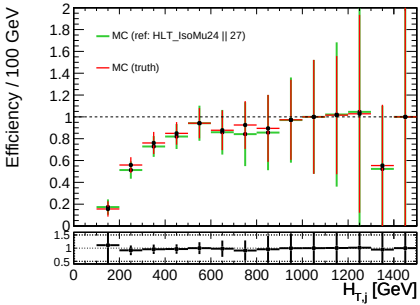

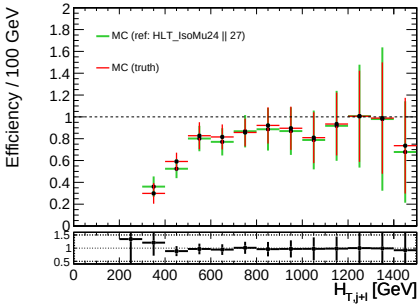

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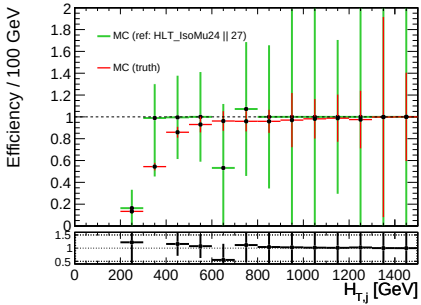
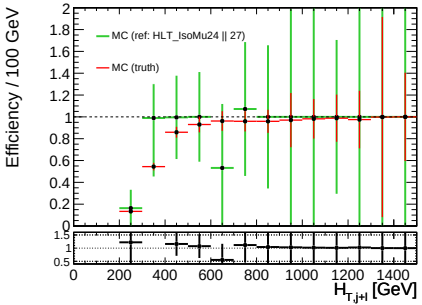
2τ 0L





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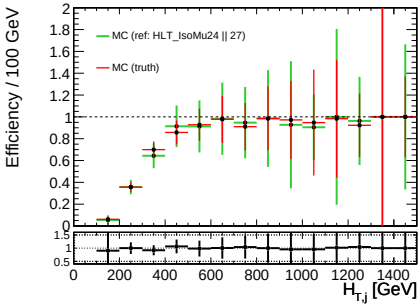
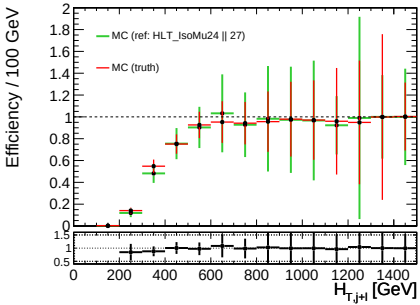
2τ 1L





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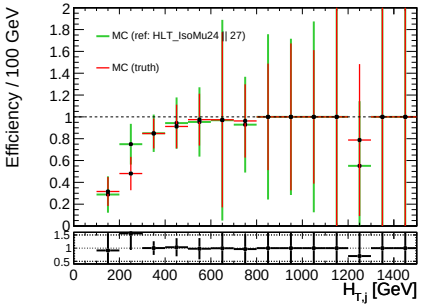
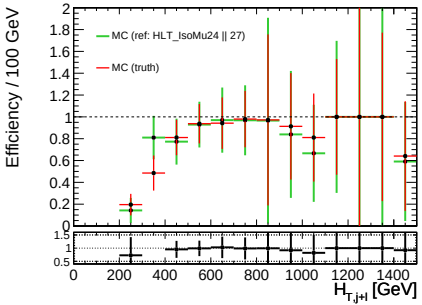
2τ 2L





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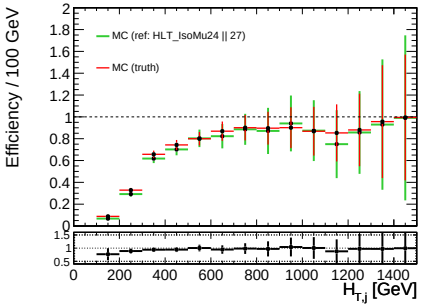
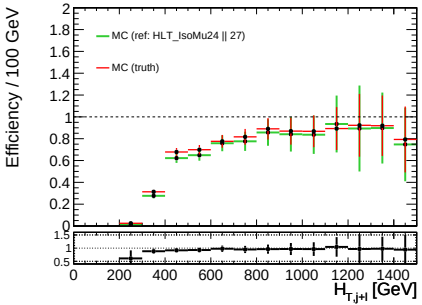
Category merging

- Some categories have high statistical fluctuations
- This can be due to orthogonal triggers or low BR
- Try to **merge categories** with many leptons (lower BRs)
- **Define multilepton (ML) categories**
  - for 1τ categories, ML means ≥ 2 leptons
  - for 2τ categories, ML means ≥ 1 leptons

1τ ML





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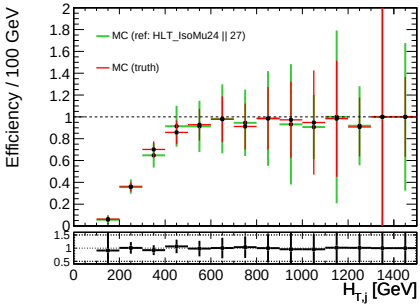

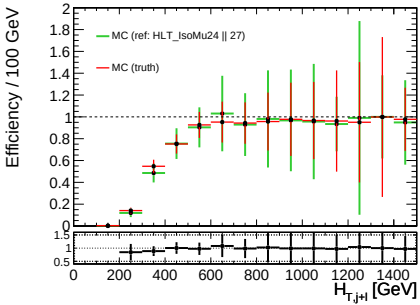

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Conclusions

- No major differences between HT(jets) and HT(jets+leptons)
- **Maybe HT(jets+leptons) slightly better?**
- Issue with TEfficiency due to negative-weighted events
  - Errors cannot be trusted
  - Some bin contents as well (> 1)
  - $t\bar{t}H(bb)$ AN uses only $t\bar{t}$ .Shall I try to use $t\bar{t}$ inclusive (and QCD?) as background? They are unweighted
- **Shall I try variable bin size?**
- Shall I look at data?