Trigger studes (fifth 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:

$$\varepsilon(H_T) = \frac{N_{\text{trig+presel}}}{N_{\text{presel}}}(H_T)$$

- **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

$$\varepsilon(H_T) = \frac{N_{\text{trig+presel+reference}}}{N_{\text{presel+referece}}}(H_T)$$

  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)

Novelties with respect to last week

- **Switched to `TEfficiency`**
    - Discarding negative-weighted events
- Treating TEfficiencies correctly:
    - Fill one `TEfficiency` object for each sample
    - Add them together weighting by $\sigma L/N_{\mathrm{gen}}$
- Study trigger efficiency in the preselection
    - Don't want to extract a single SF for each category (right?)
- Add the request for **exactly 1 tight muon to preselection**
    - Make the reference trigger fire
- Use only $t\bar{t}$ for these studies
    - Argue that asking for 1 muon makes $t\bar{t}$ the dominant bkg
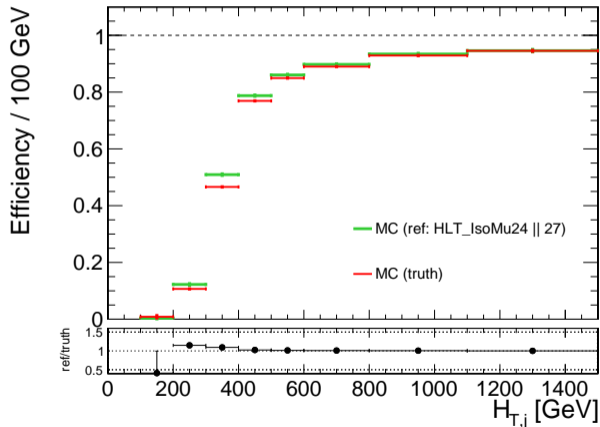
Trigger efficiency
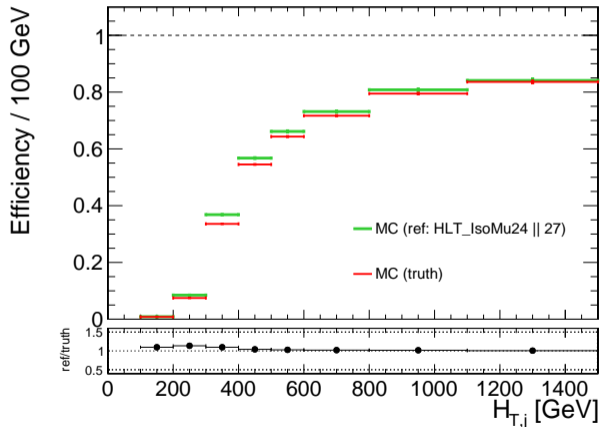
- Preselection $+ 1\mu$
- Reference is almost unbiased
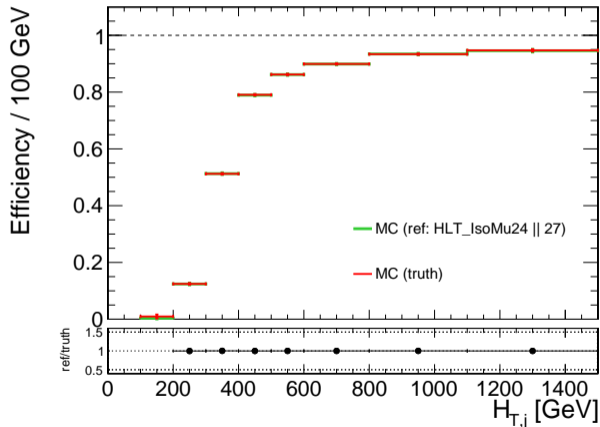- Efficiency $\approx 80\%$ on the plateau

Trigger efficiency

- Preselection $+ 1\mu$ $+ N_{jets} \geq 6$
- Reference is almost unbiased
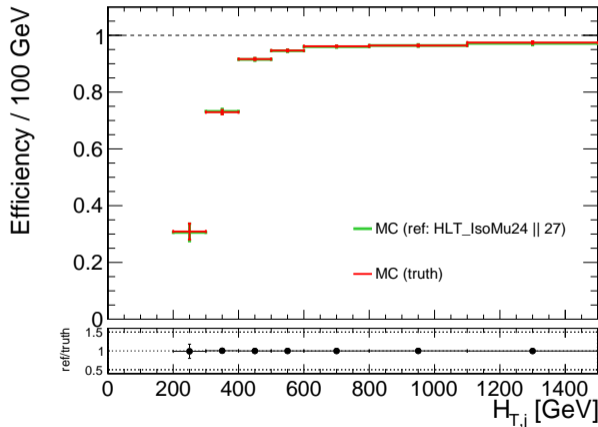- Efficiency $\approx 90\%$ on the plateau

Trigger efficiency

- Preselection $+ 1\mu$ $+ N_{jets} \geq 6 +$ $p_{T,\mu} > 25$ GeV
- Reference is almost unbiased
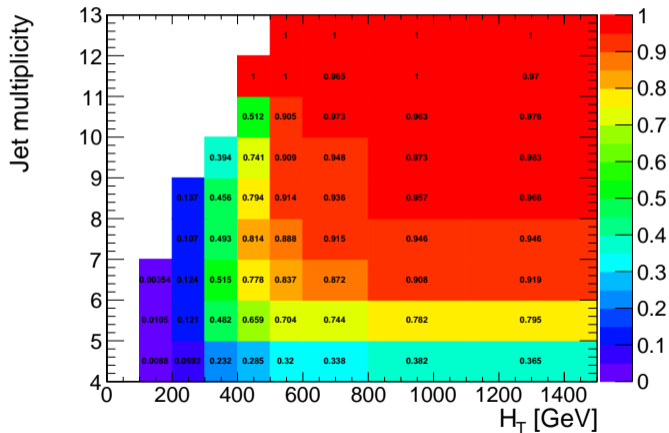- Efficiency $\approx 90\%$ on the plateau

Trigger efficiency

- Preselection $+ 1\mu$ $+ N_{jets} \geq 6 +$ $p_{T,\mu} > 25$ GeV $+$ $p_{T,\text{jet}} > 35$ GeV
- Reference is almost unbiased
- Efficiency $> 95\%$ on the plateau
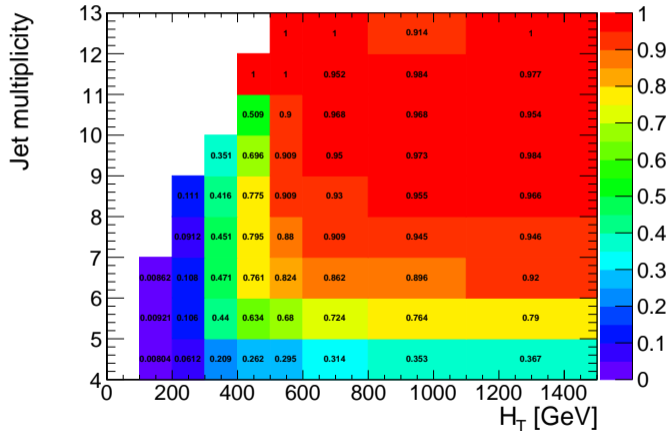
2D Trigger efficiency
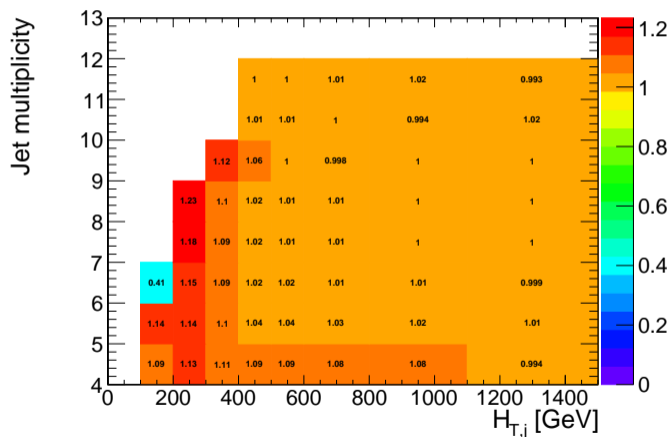
- **wrt reference**
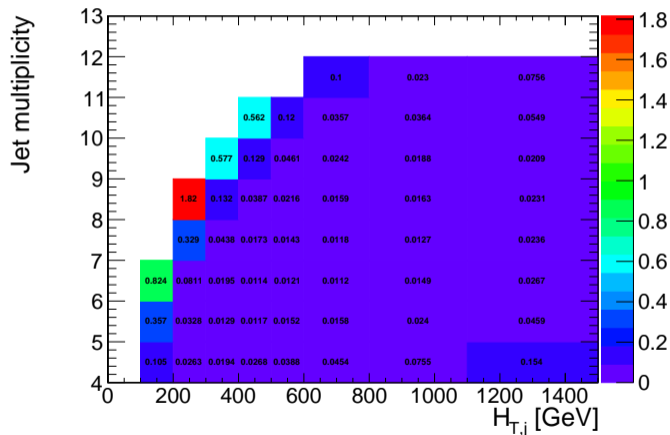- Preselection $+ 1\mu$

2D Trigger efficiency

- **truth efficiency**
- Preselection $+ 1\mu$

2D Trigger efficiency

- **ratio ref/truth**
- Preselection $+ 1\mu$
- Ratio is very close to 1: reference is unbiased

2D Trigger efficiency

- **errors**
- Preselection $+ 1\mu$
- Quadrature sum of errorUp and errorLow for num and den
- Propagate these error to the ratio

Conclusions

- All these **plots** are computed **wrt HT(jets)**
    - I can check HT(jets+leptons)
- I can add more processes (easy now that I have a basis)
- My opinions:
    - The results make sense in general
    - The more the cuts, the higher the efficiency
    - In the phase space in which both the signal and reference triggers are efficient, the reference is fully unbiased
    - 2D plots make sense as well
- Am I ready to see what happens in data?