



Trigger studies: a look at data (sixth part)

Fabio Lemmi¹ Huiling Hua¹
Hongbo Liao¹ Hideki Okawa² Yu Zhang²

¹Institute of High Energy Physics (IHEP), Beijing

²Fudan University, Shanghai

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- **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 $t\bar{t}H(bb)$



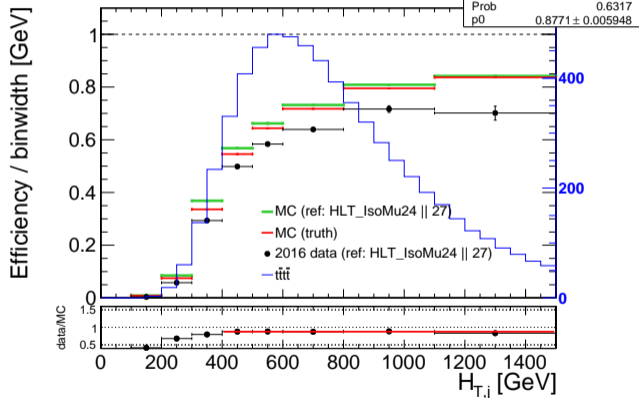
- **Use TEfficiency**
 - Discarding negative-weighted events
- Treating TEfficiencies correctly:
 - Fill one TEfficiency object for each sample
 - Add them together weighting by $\sigma L/N_{\text{gen}}$
- Study trigger efficiency in the preselection
- Add the request for **exactly 1 tight muon to preselection**
 - Make the reference trigger fire
- Use $t\bar{t}\bar{t}$, $t\bar{t}$, $t\bar{t}+X$ and QCD as MC processes
- **Compute efficiency in data and compare with MC**

Trigger efficiency



Trigger
efficiency

F. Lemmi



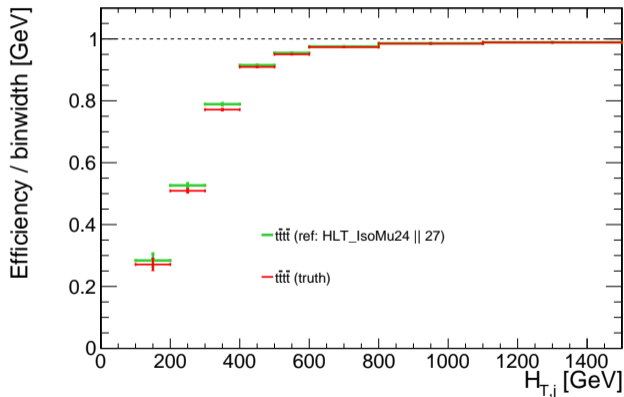
- Preselection + 1μ
- Non-negligible flat scale factor
- **Fitted the ratio with a constant line**
- $SF = 0.8771 \pm 0.005948$
- **Also plotted H_T distribution for signal**

Trigger efficiency: signal



Trigger
efficiency

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- Preselection + 1μ
- High efficiency on signal
- Confirming what we saw in “inclusive” efficiency



- It seems that the **efficiency in data is lower** by a non-negligible amount
- I found the following in the **$t\bar{t}H(b\bar{b})$ AN**:

270 Initially a drop in efficiency in data at high HT was observed, which is attributed to the last
271 run period of the LHC in 2016 (Run H) which had very high instantaneous luminosity. The
272 L1 HT triggers suffered a problem in which saturated (high p_T) jets were excluded from the
273 HT calculation [62]. A partial mitigation strategy of including an OR of a single jet trigger
274 HLT_PFJet450_v* has been implemented, which recovers most of the lost efficiency at high
275 HT.

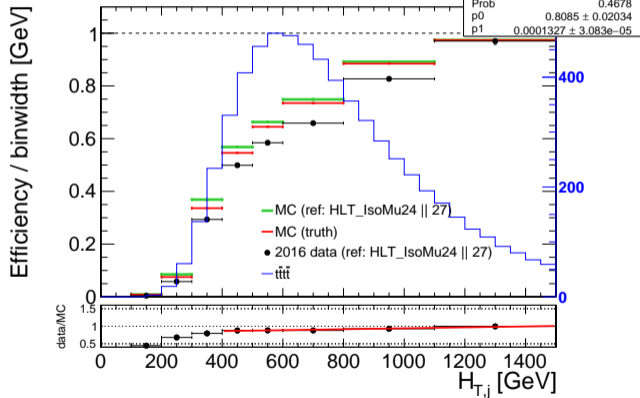
- Worth looking at HLT_PFJet450_v
 - We have it available in the ntuples

Trigger efficiency: adding HLT_PFJet450 to signal triggers



Trigger
efficiency

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- Preselection + 1μ
- Data and MC are closer
- Fitted the ratio with a straight line of the form

$$y = mx + q$$

$$m = 0.0001327 \pm 3.083e-05$$
$$q = 0.8085 \pm 0.02034$$

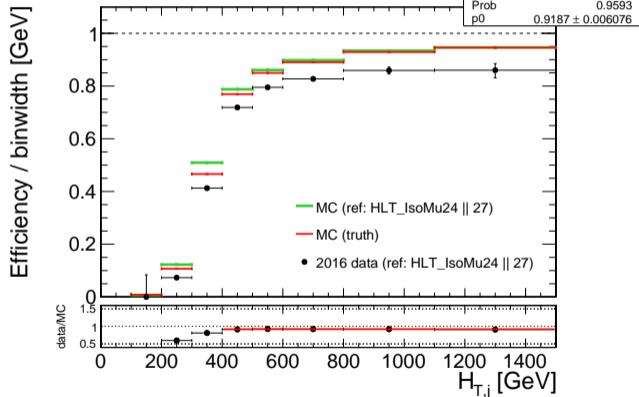
- Also plotted H_T distribution for signal

Trigger efficiency



Trigger
efficiency

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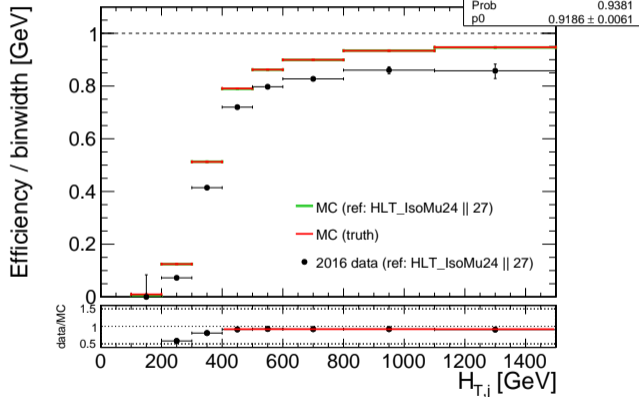
- Preselection + 1μ + $N_{\text{jets}} \geq 6$
- Fitted the ratio with a constant line
- SF = 0.9187 ± 0.006076
- SF closer to 1

Trigger efficiency



Trigger
efficiency

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- Preselection + 1μ + $N_{\text{jets}} \geq 6 + p_{T,\mu} > 25$ GeV
- Fitted the ratio with a constant line
- $SF = 0.9186 \pm 0.0061$
- SF almost unchanged

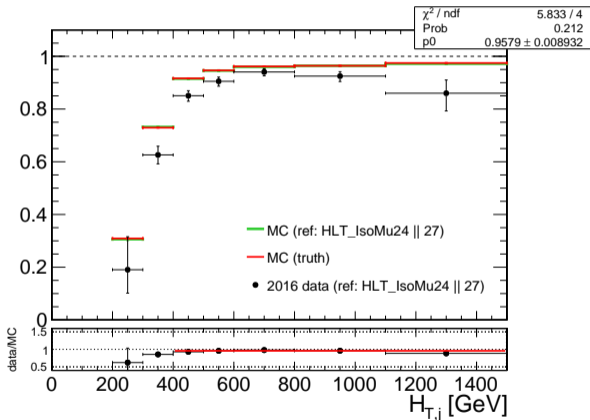
Trigger efficiency



Trigger
efficiency

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Efficiency / binwidth [GeV]



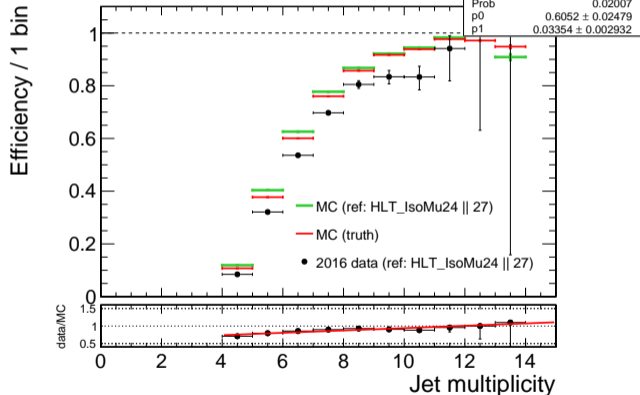
- Preselection + 1μ + $N_{\text{jets}} \geq 6 + p_{T,\mu} > 25$ GeV + $p_{T,\text{jet}} > 35$ GeV
- Fitted the ratio with a constant line
- SF = 0.9579 ± 0.008932
- SF closer to 1

Trigger efficiency



Trigger
efficiency

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- Preselection + 1μ
- Non-negligible flat scale factor
- **Fitted the ratio with a straight line of the form**

$$y = mx + q$$

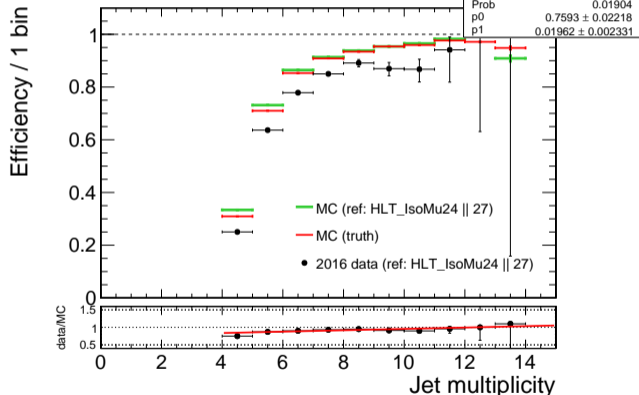
$$m = 0.03354 \pm 0.002932$$
$$q = 0.6052 \pm 0.02479$$

Trigger efficiency



Trigger
efficiency

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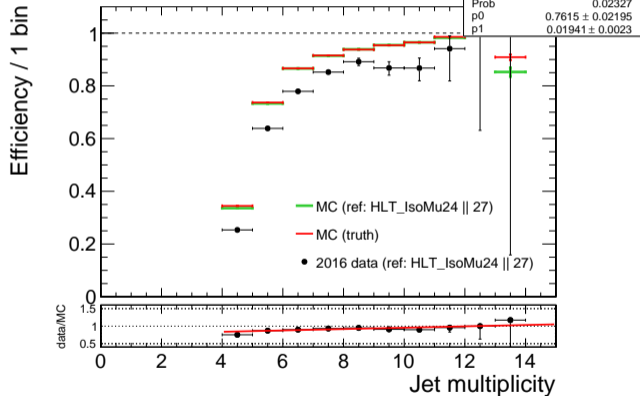
- Preselection + 1μ + HT(jets) > 500 GeV
- Fitted the ratio with a straight line
- SF = 0.9187 ± 0.006076
-
- $m = 0.01962 \pm 0.002331$
- $q = 0.7593 \pm 0.02218$
- Line is flatter

Trigger efficiency



Trigger
efficiency

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- Preselection + 1μ + HT(jets) > 500 GeV + $p_{T,\mu} > 25$ GeV
- Fitted the ratio with a straight line
-

$$m = 0.01941 \pm 0.0023$$

$$q = 0.7615 \pm 0.02195$$

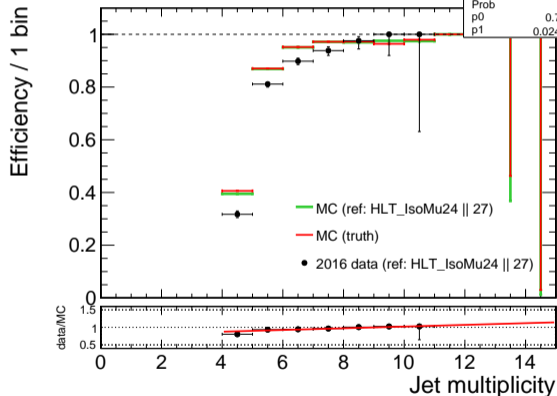
- No big changes in parameters

Trigger efficiency



Trigger
efficiency

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- Preselection + 1μ + $HT(\text{jets}) > 500 \text{ GeV}$ + $p_{T,\mu} > 25 \text{ GeV}$ + $p_{T,\text{jet}} > 35 \text{ GeV}$
- Fitted the ratio with a straight line
-

$$m = 0.02432 \pm 0.004449$$

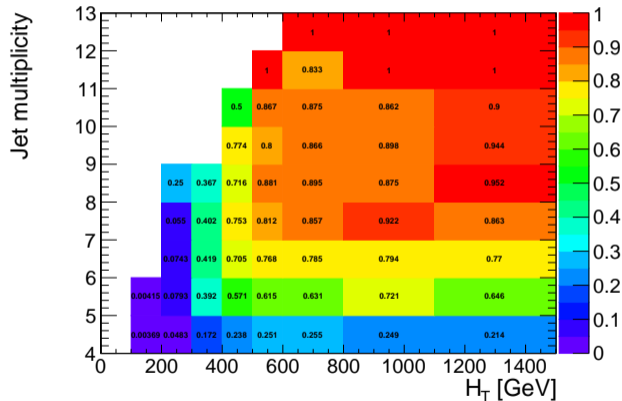
$$q = 0.7786 \pm 0.03653$$

2D Trigger efficiency: DATA



Trigger efficiency

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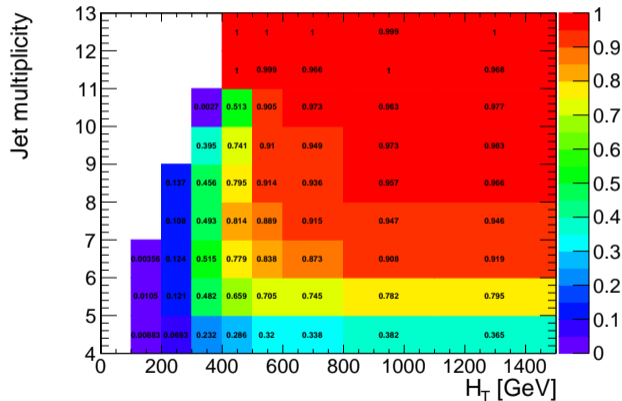
- Preselection + 1μ

2D Trigger efficiency: MC



Trigger efficiency

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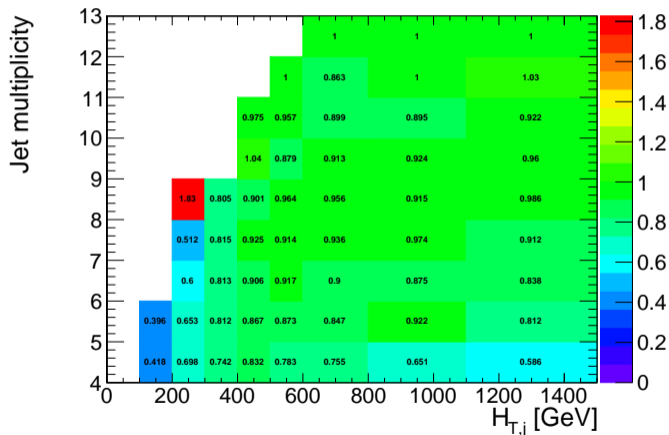
- Preselection + 1μ

2D Trigger efficiency: DATA/MC



Trigger
efficiency

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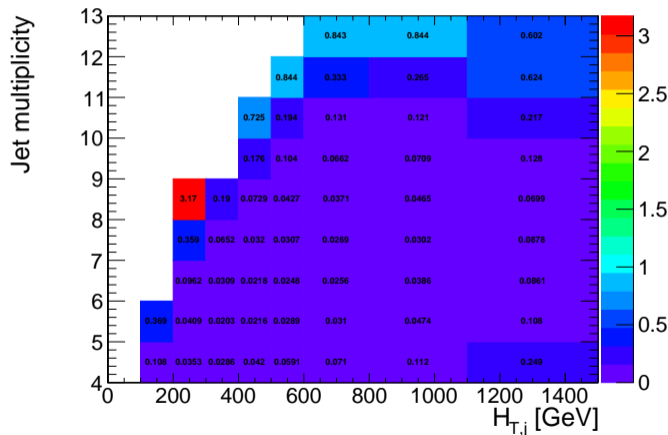
- Preselection + 1μ
- ZhangYu spotted some **discrepancy at high HT**, see the following for partial solution

2D Trigger efficiency: DATA/MC errors



Trigger efficiency

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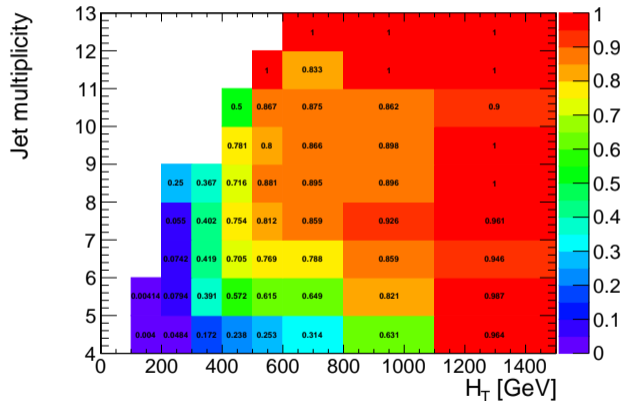
● Preselection + 1μ

2D Trigger efficiency: DATA (HLT_PFJet450)



Trigger efficiency

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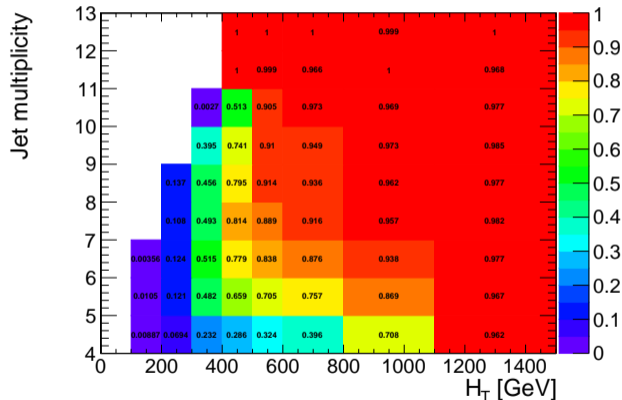
● Preselection + 1μ

2D Trigger efficiency: MC (HLT_PFJet450)



Trigger efficiency

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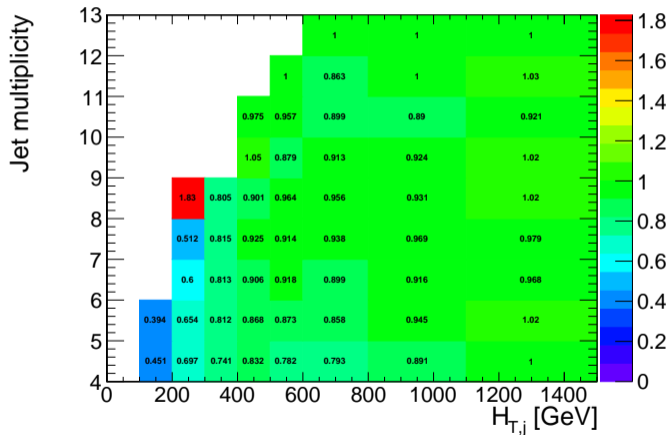
● Preselection + 1μ

2D Trigger efficiency: DATA/MC (HLT_PFJet450)



Trigger efficiency

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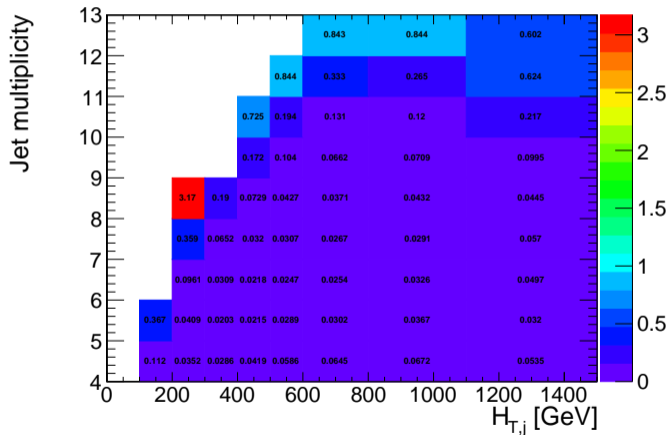
- Preselection + 1μ
- Agreement is improved in high HT region

2D Trigger efficiency: DATA/MC errors (HLT_PFJet450)



Trigger efficiency

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● Preselection + 1μ



- All these **plots** are computed **wrt HT(jets)**
 - No major differences when I try HT(jets+leptons)
- We **may need to add HLT_PFJet450** to our signal triggers to recover some efficiency in data at high HT
- I wonder if I should increase the range of histograms in HT
 - It seems that I still have statistics at 1500 GeV
 - It seems that the gap DATA/MC is reducing while going up in HT