Trigger studies with UL2016/2018

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Summary from last time

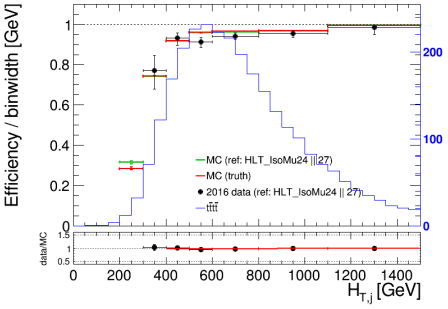
- Last time we agreed **we need a better** (i.e., steeper) **turn on** for our triggers
- This will let us **place ourselves on the** trigger **efficiency plateau**
- Thresholds change a bit year-by-year, but in general triggers ask for:
  1. HT $>$ *xxx*
  2. At least six jet with pt $>$ *yyy*
  3. One or two b tags
- This means that our **preselection should include the following**:
  - At least six jets
  - At least two b tags (it has this already)
  - Some lower bound on jets pt
- This also means that **we can't trigger 1tau3L and 2tau2L with multijet triggers**
  - Drop them for now (?)

New preselection

- I propose to adopt the preselection choices that ttH(bb) people use
  - At least six jets
  - 6th jet $p_T > 40$ GeV
- Jets are sorted in $p_T \implies$ all first six jets will be above trigger threshold
- Old preselection was:
  1. ≥ 1 loose taus
  2. ≥ 2 jets (definitely too low!)
  3. ≥ 2 loose btags
- New preselection would be:
  1. ≥ 1 loose taus
  2. ≥ 6 jets
  3. ≥ 2 loose btags
  4. 6^{th} jet $p_T > 40$ GeV

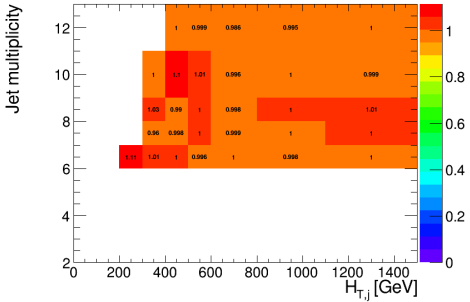
UL2016 preVFP

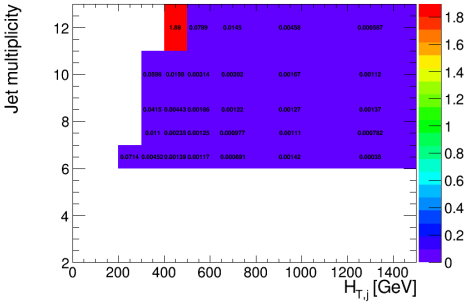
1D trigger efficiency plots



- Trigger choice: unchanged wrt preUL
- OR of:
  - `HLT_PFHT450_SixJet40_BTagCSV_p056`
  - `HLT_PFHT400_SixJet30_DoubleBTagCSV_p056`
  - `HLT_PFJet450`
- Reference triggers: OR of
  - `HLT_IsoMu24`
  - `HLT_IsoMu27`
- Selection:
  - **New preselection**
  - $== 1\ \ell$, $== 1\ \mu$
  - Designed to have reference firing

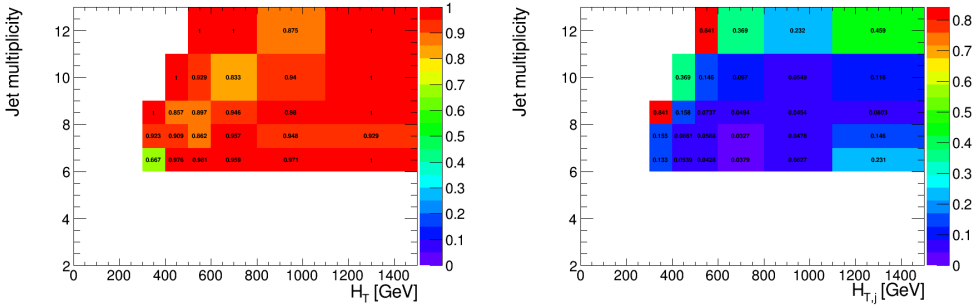
2D plots: checking the reference trigger





- nJets vs H_T trigger efficiency
- Left: MC/MCtruth efficiency ratio; right: corresponding errors
- The reference is unbiased in 2D too

2D plots: trigger efficiency in data



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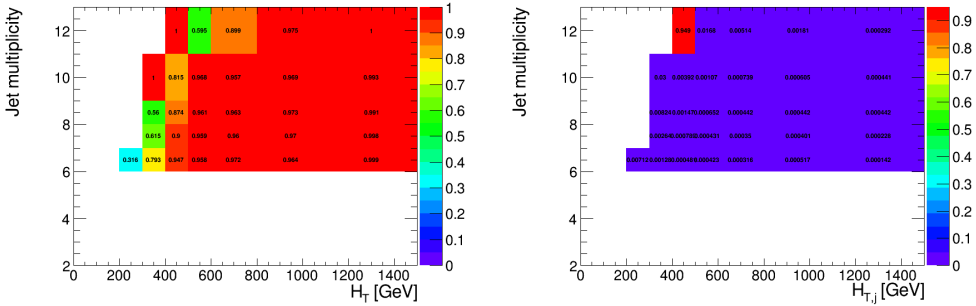
2D plots: trigger efficiency in MC



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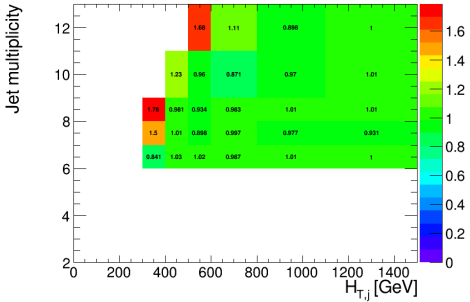
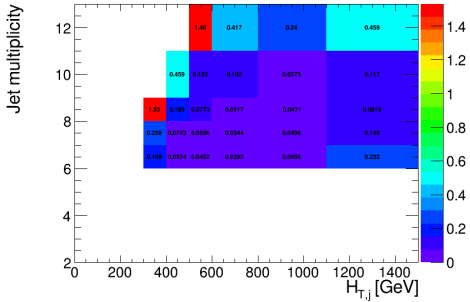
2D plots: data/MC efficiency ratio

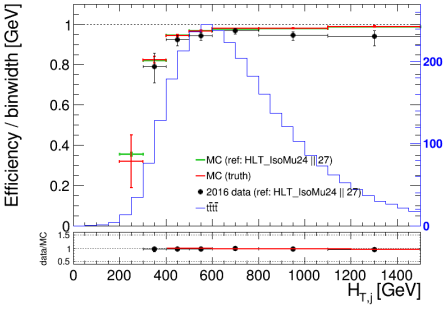




- nJets vs H_T data/MC efficiency ratio
- Left: trigger efficiency; right: corresponding errors
- Somehow bigger errors and a bit more spiky (lower data stats)

UL2016 postVFP

1D trigger efficiency plots



- Trigger choice: unchanged wrt preUL
- OR of:
  - `HLT_PFHT450_SixJet40_BTagCSV_p056`
  - `HLT_PFHT400_SixJet30_DoubleBTagCSV_p056`
  - `HLT_PFJet450`
- Reference triggers: OR of
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  - `HLT_IsoMu27`
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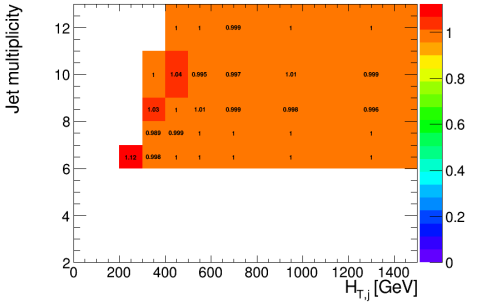
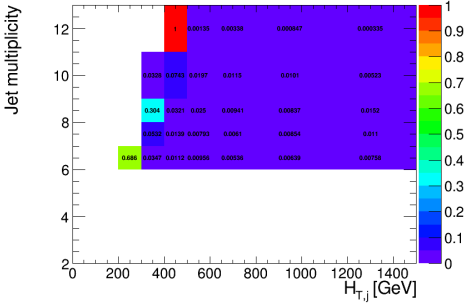
2D plots: checking the reference trigger





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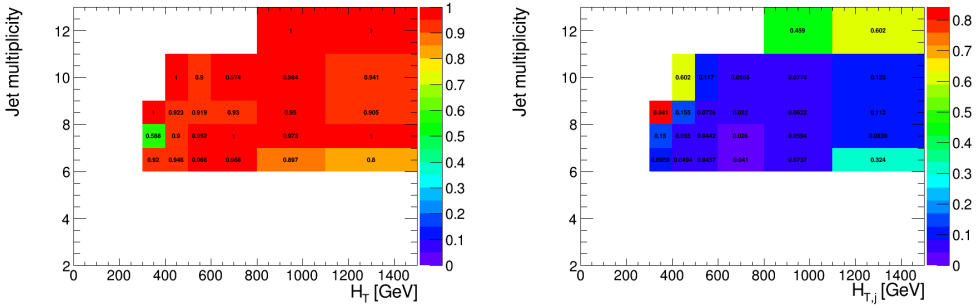
2D plots: trigger efficiency in data



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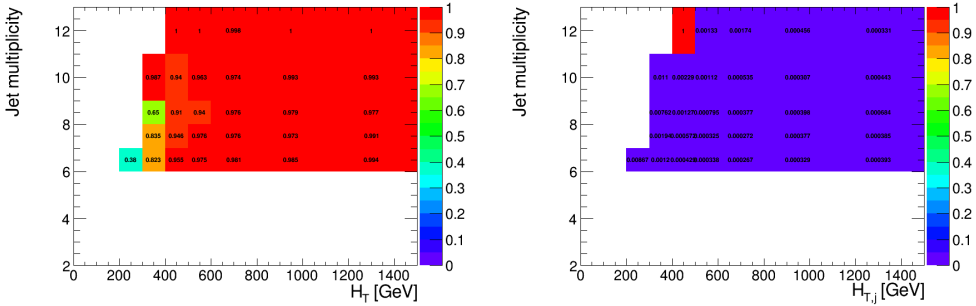
2D plots: trigger efficiency in MC



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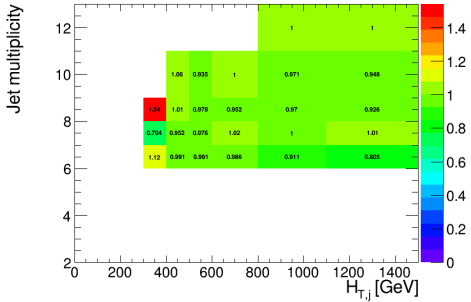
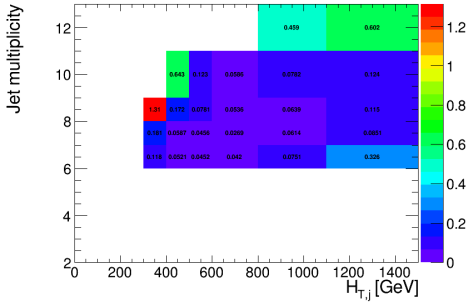
2D plots: data/MC efficiency ratio





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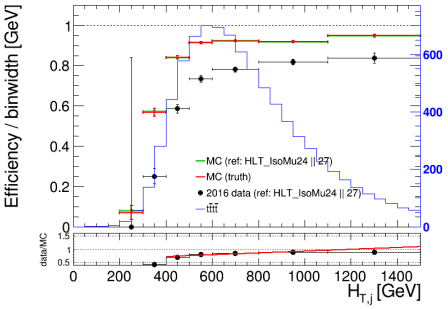
UL2018

1D trigger efficiency plots



- Trigger choice: unchanged wrt preUL
- OR of:
  - `HLT_PFHT400_SixPFJet32_DoublePFBTagDeepCSV_2p94`
  - `HLT_PFHT450_SixPFJet36_PFBTagDeepCSV_1p59`
  - `HLT_PFJet500`
- Reference triggers: OR of
  - `HLT_IsoMu24`
  - `HLT_IsoMu27`
- Selection:
  - **New preselection**
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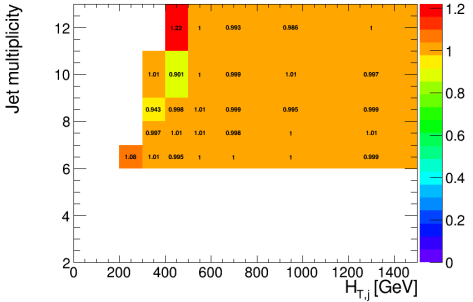
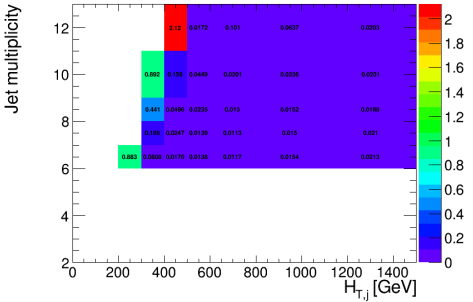
2D plots: checking the reference trigger





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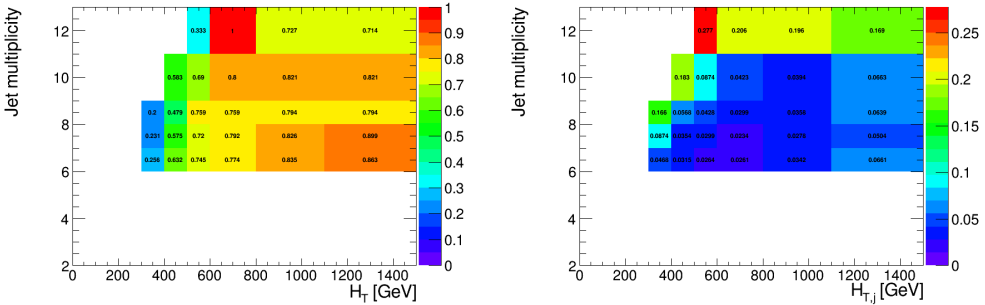
2D plots: trigger efficiency in data



- nJets vs H_T trigger efficiency in data
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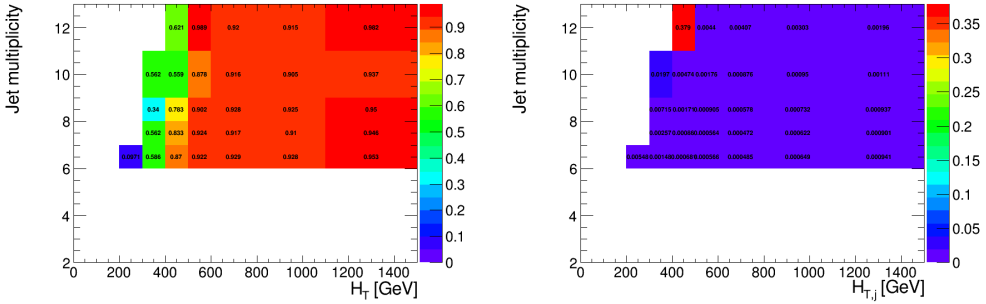
2D plots: trigger efficiency in MC



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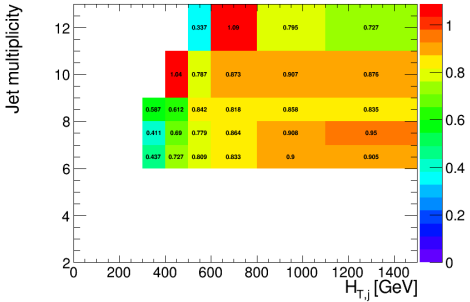
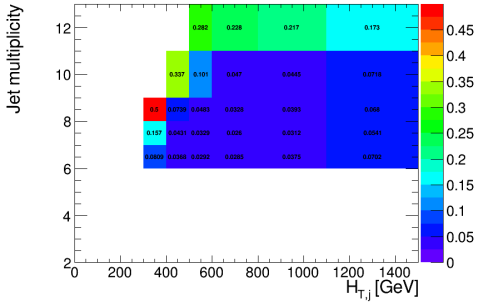
2D plots: data/MC efficiency ratio





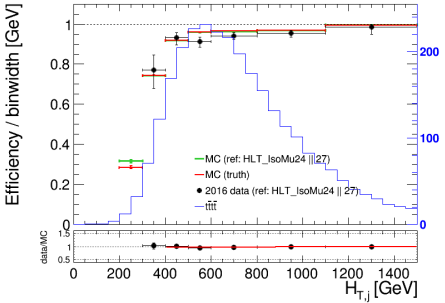
- nJets vs H_T data/MC efficiency ratio
- Left: trigger efficiency; right: corresponding errors
- Eff in data lower than in MC (as we see in 1D)

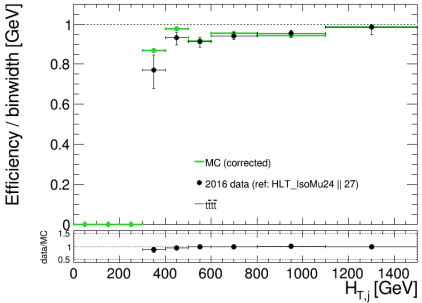
Closure tests

Closure tests

- **See if the 2D correction factors really help** in correcting data/MC efficiency agreement
- Do not apply the 2D corrections to 2D efficiencies (will work by construction)
- **Apply 2D corrections to 1D efficiencies**
- For each bin in HT, the correction is the **average over the Njet bins**
  - Do not consider bins where the relative uncertainty on the SF is $> 50\%$

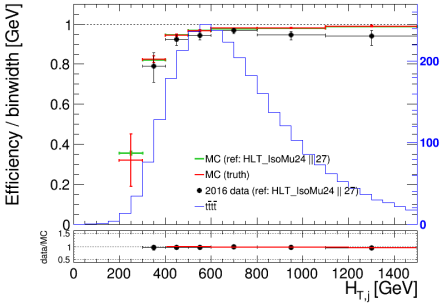
Closure test – UL2016_preVFP

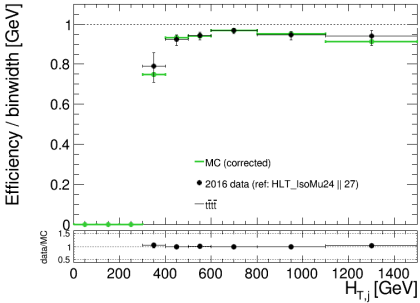




- Left: uncorrected; right: corrected

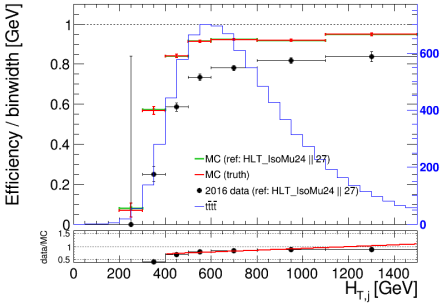
Closure test – UL2016_postVFP

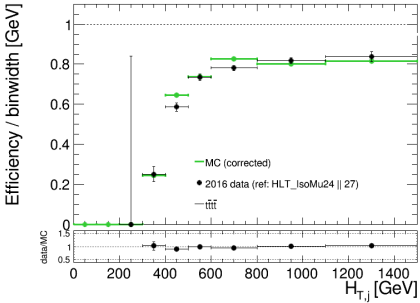




- Left: uncorrected; right: corrected

Closure test – UL2018





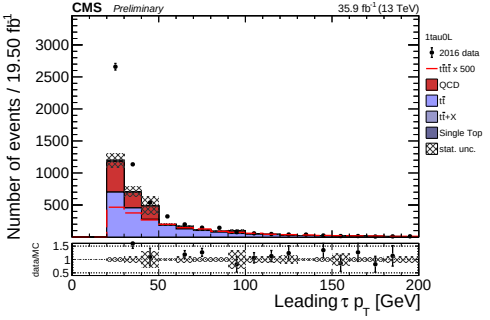
- Left: uncorrected; right: corrected

New category cuts?

Category	Njets exp. in sig.	Our cut	New cut ?
1tau0L	10	≥ 8	≥ 8
1tau1L	8	≥ 6	≥ 7
1tau2L	6	≥ 4	≥ 6
1tau3L	4	≥ 2	drop this cat
2tau0L	8	≥ 6	≥ 7
2tau1L	6	≥ 4	≥ 6
2tau2L	4	≥ 2	drop this cat

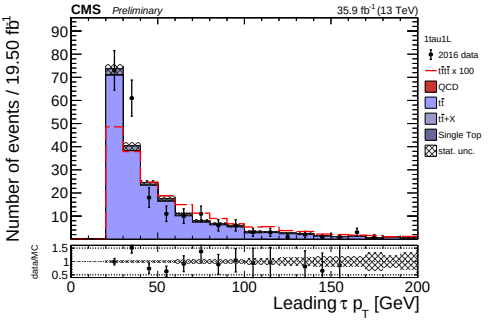
- Njets we request is 2 less than the expected number from signal
- What happens if we increase it?
- Also apply HT $>$ 500 cut

1tau0L (UL2016_preVFP)



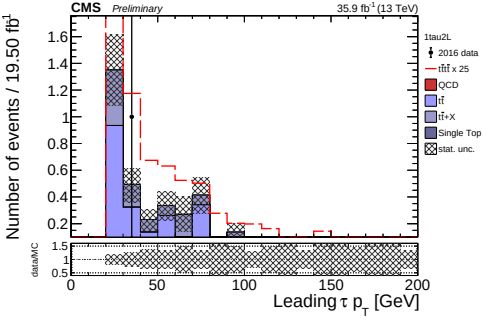

```
======== taus_1pt 1tau0L ======================
Data events:  5572
signal events: 4.15303
ttbar events: 2198.22
QCD events: 1098.9
tt+X events:   61.2099
single top events:   0.0921935
total MC events: 3358.42
data/MC agreement: 65.9116%
```

1tau1L (UL2016_preVFP)



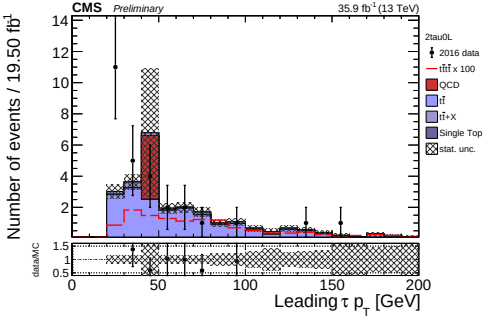

```
======== taus_1pt 1tau1L ====================
Data events:  213
signal events: 2.07167
ttbar events: 198.833
QCD events: 0
tt+X events:   11.7571
single top events:   0.0378044
total MC events: 210.627
data/MC agreement: 1.1264%
```

1tau2L (UL2016_preVFP)



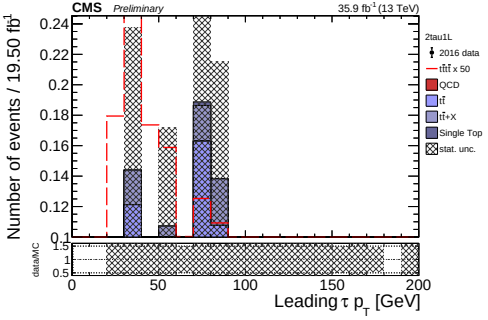

```
======== taus_1pt 1tau2L ======================
Data events:  2
signal events: 0.284512
ttbar events: 2.58733
QCD events: 0
tt+X events:   1.26113
single top events:   -0.0121296
total MC events: 3.83632
data/MC agreement: -47.8668%
```

2tau0L (UL2016_preVFP)




```
======== taus_1pt 2tau0L ======================
Data events:  29
signal events: 0.132715
ttbar events: 19.9434
QCD events: 4.08559
tt+X events:   1.90502
single top events:   0.025235
total MC events: 25.9593
data/MC agreement: 11.7134%
```

2tau1L (UL2016_preVFP)




```
======== taus_1pt 2tau1L ====================
Data events:  0
signal events: 0.0339485
ttbar events: 0.794889
QCD events: 0
tt+X events:   0.231229
single top events:   0.00237083
total MC events: 1.02849
data/MC agreement: -100%
```

Conclusions

- In the **new preselection**, the turn-ons look way nicer and steeper
- With a cut like **HT $>$ 500 GeV** we can be **on the plateau for all years**
- I am really convinced this is the way to go
  - Only "problem": I hope it won't make QCD estimation harder
- Also, the **corrections** seem to **work properly**
- The **categories** would have **lower stat**
  - How to deal with this? Should we treat 2016 pre/post VFP as one single thing? (I think so...)
- **What do you think about all these things?**