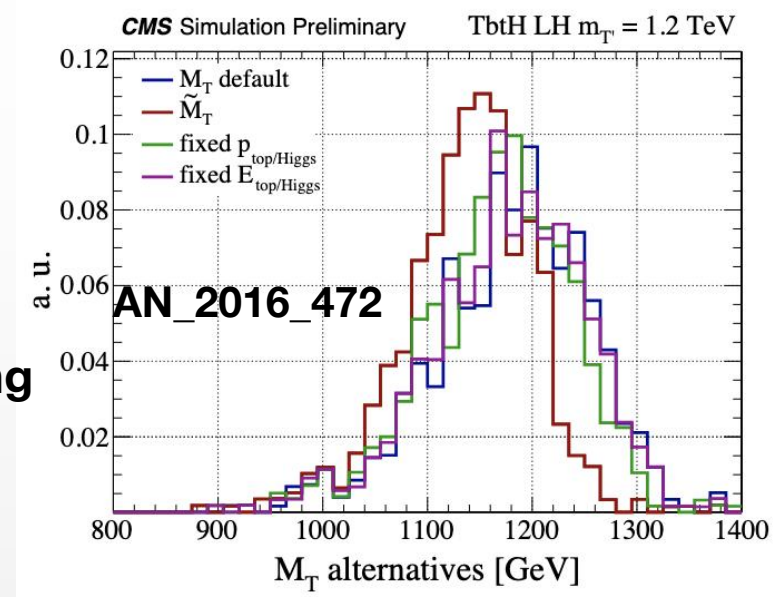
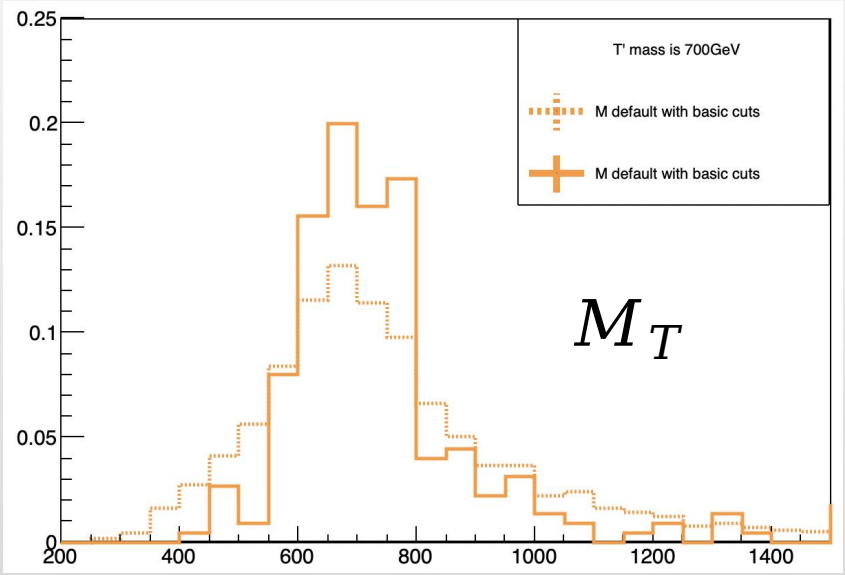
New Way to Reconstruct T' Mass

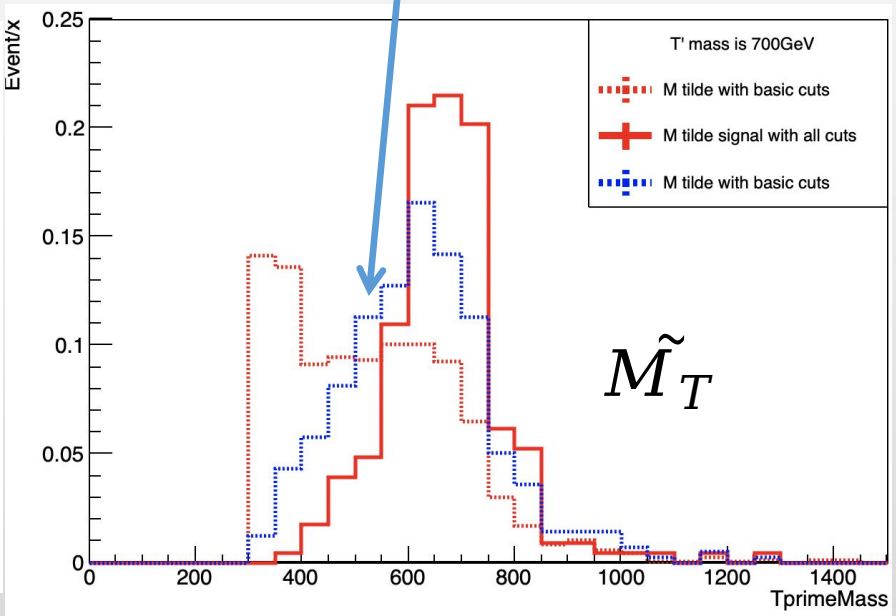
- An interesting way to reconstruct T' mass in CMS-B2G-20-007 (page 7)
  - Decay products of boosted H decay are collimated: assume that $\theta_{inv} = \theta_{ll}$
    - $Px_{inv} = MET\_pt * cos(MET\_\phi)$
    - $Py_{inv} = MET\_pt * sin(MET\_\phi)$
    - $Pz_{inv} = MET\_pt/tan(\theta_{inv})$=$MET\_pt/tan(\theta_{ll})$
  - Invariant mass due to the neutrinos is obtained from GEN neutrino
    - A small conflict between B2G-20-007 and me
      - CMS-B2G-20-007: 55GeV
      - My own preliminary result: 30GeV (*needs double check*)
      - Maybe caused by potential mistake in my calculation or difference from physics processes (*needs double check*)
- A method to "constraint" T' mass from AN_2016_472 (line 548)
  - $\tilde{M_T} = M_T - \sqrt{E_H^2 - \vec{p}_H^2} - \sqrt{E_{top}^2 - \vec{p}_{top}^2} + m_H^{pole} + m_{top}^{pole}$
  - It makes the background more like a background and the signal more like a signal

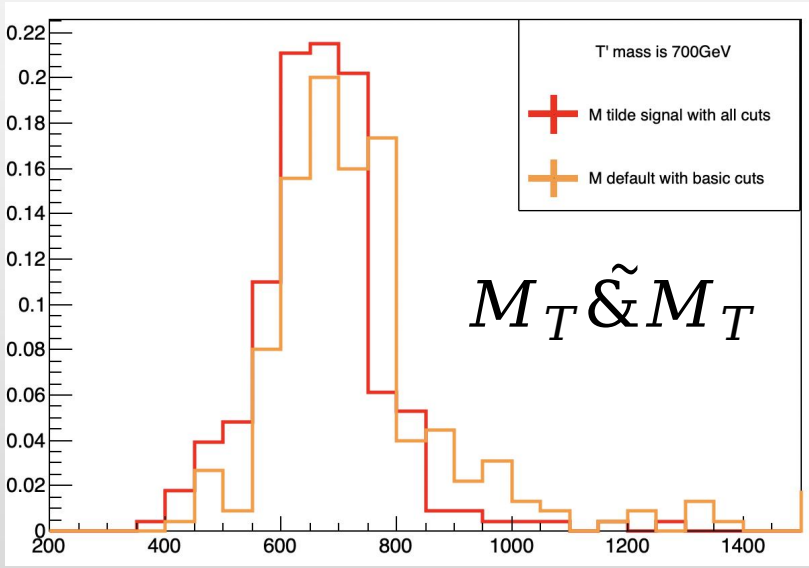
T' Mass tilde

- $\tilde{M}_T$ method reduces the tail of the signal
  - $\tilde{M}_T = M_T - \sqrt{E_H^2 - \vec{p}_H^2} - \sqrt{E_{top}^2 - \vec{p}_{top}^2} + m_H^{pole} + m_{top}^{pole}$
  - It makes the background looks more like background
    - That's why $\tilde{M}_T$ after basic cuts doesn't look like a peak/bump
      - There are many non-signal events after basic cuts according to previous study
      - See GEN signal after basic cuts (blue dash line)



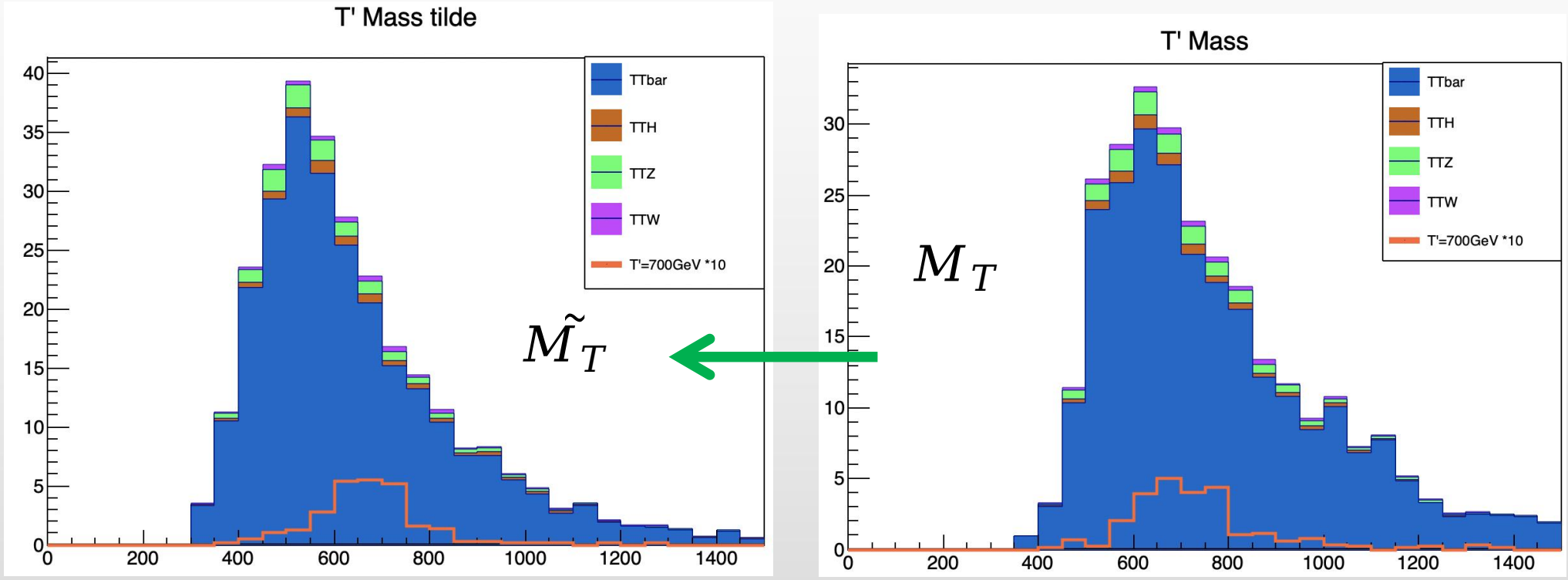






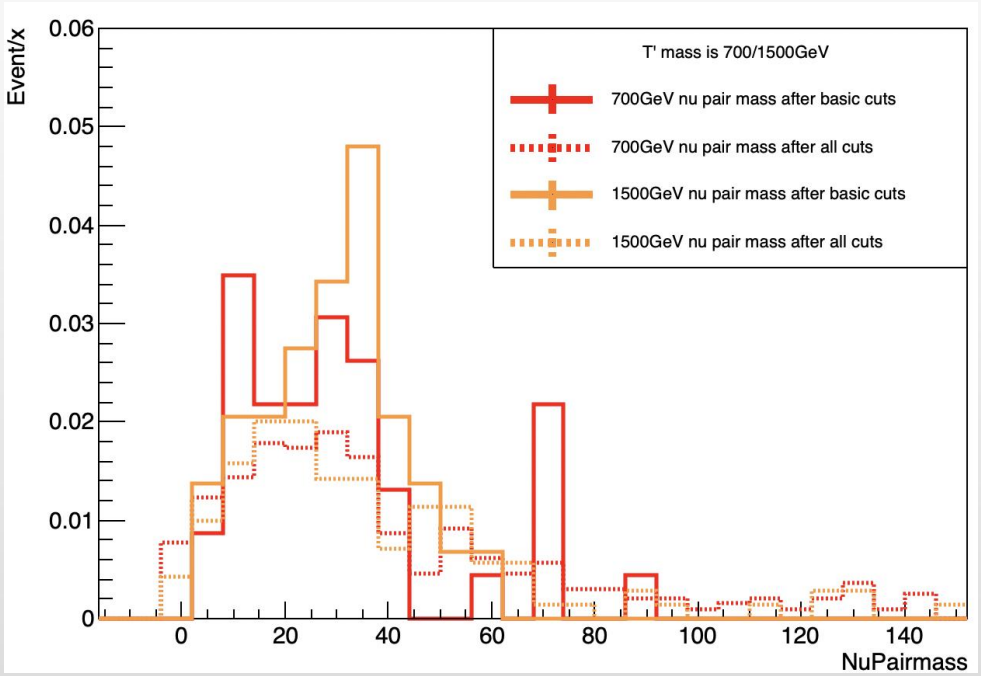
T’ Mass tilde

- $\tilde{M}_T$ **method makes the background looks more like background**
  - **background becomes a smooth falling spectrum**



Invariant mass from the neutrinos

- Get 4momentum of 2 GEN neutrinos
  - 2 neutrinos in 1 event with pdgID 14 & -14
    - *could be improved*
  - mean value after basic cuts: 39GeV
  - mean value after all cuts: 30GeV
  - No major difference between 700GeV& 1500GeV samples



HH Reconstruction 2ℓ

H_{lep} momentum = $p_{\ell\ell}$ + p_{inv}

Need to solve for the invisible momentum in the event (2 or 4 neutrinos)

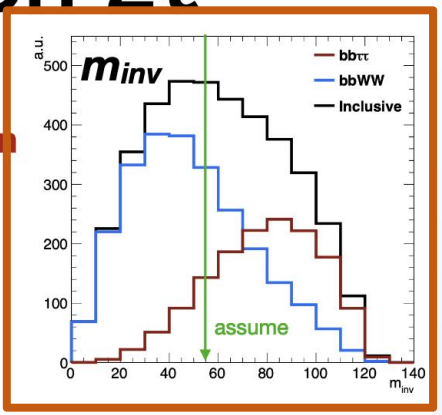
Use MET directly as the invisible p_x and p_y

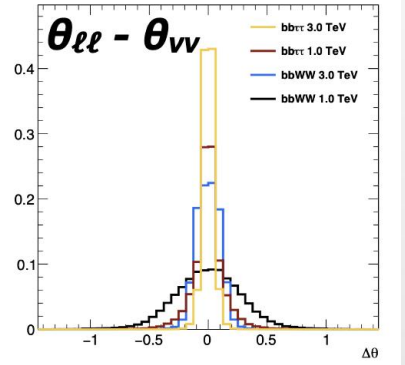
Simple assumptions for rest of p_{inv} based on signal simulation

1. m_{inv} = 55 GeV (incl spectrum ~ symmetric)
2. $\theta_{inv} = \theta_{\ell\ell}$ (boosted collinear approximation)

Similar mass resolution as for a likelihood-based method

Dominating effect on mass res. is the bb jet mis-measurements on the other side of the event





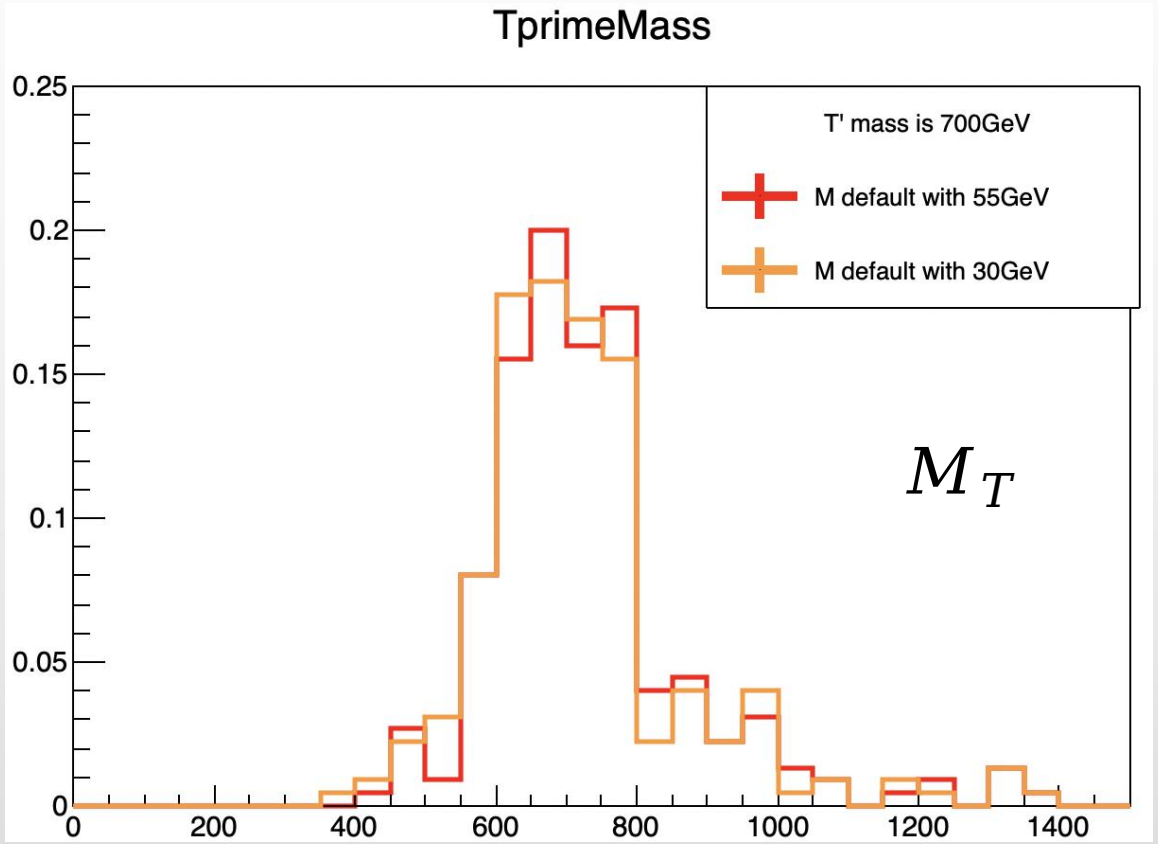
From B2G-20-007

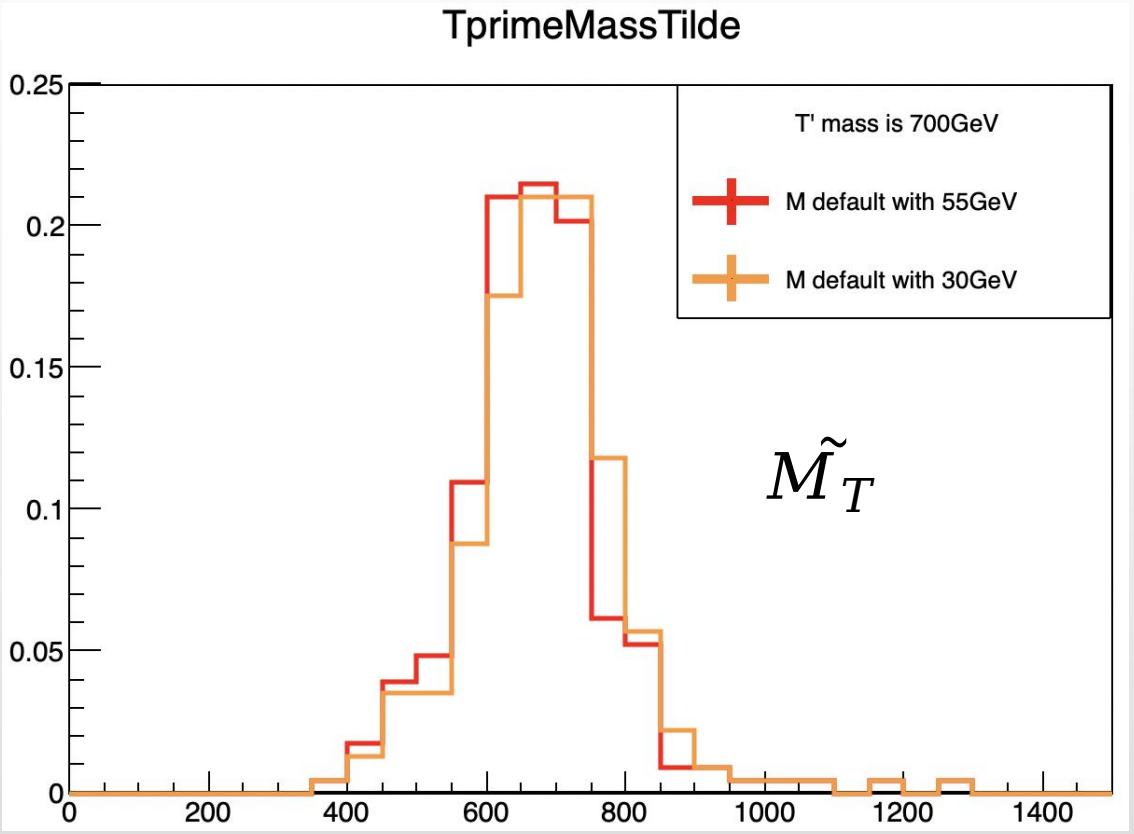
Need more study to understand the difference!

Invariant mass from the neutrinos

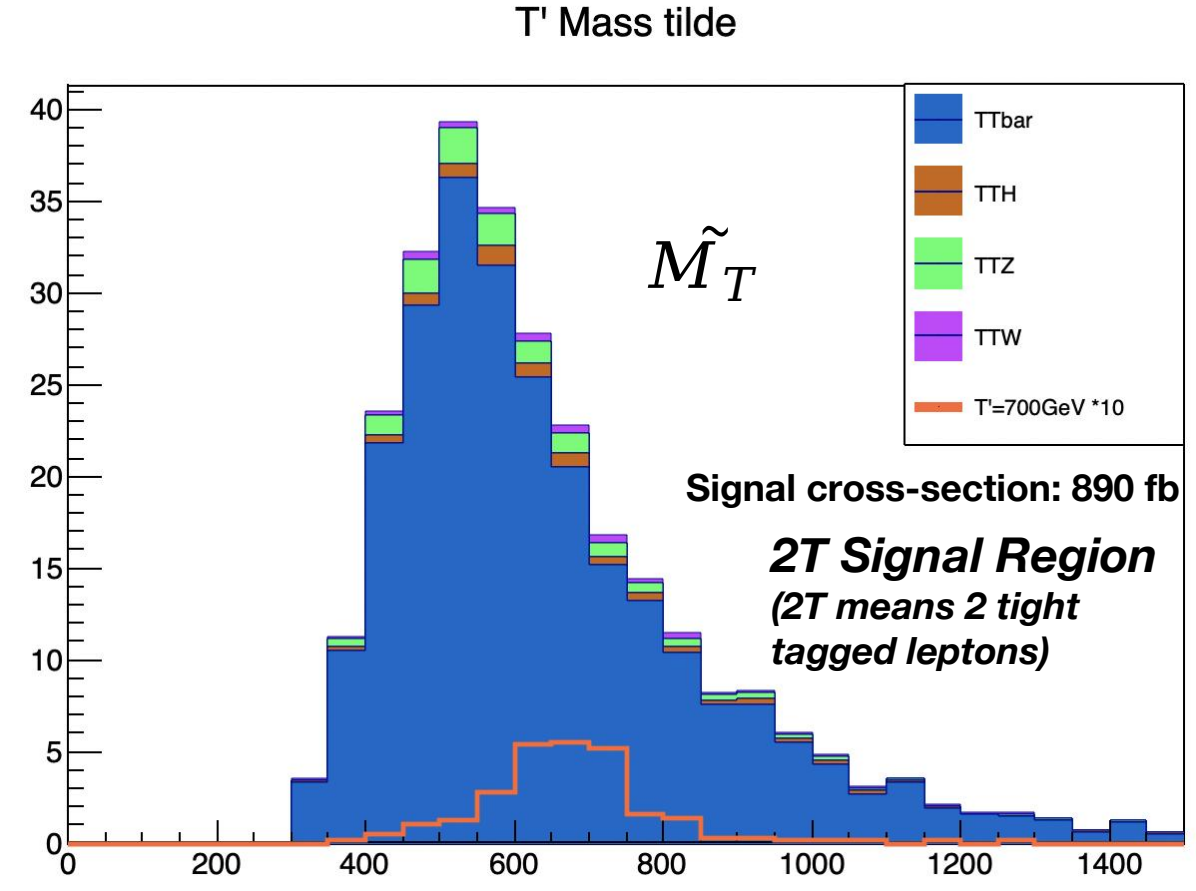
M_T and $\tilde{M_T}$ distribution with $m_{inv} = 55/30\ GeV$

- **<10GeV difference**
- **Still need more study about the m_{inv}**





T’ Mass tilde stack plot (after all cuts)



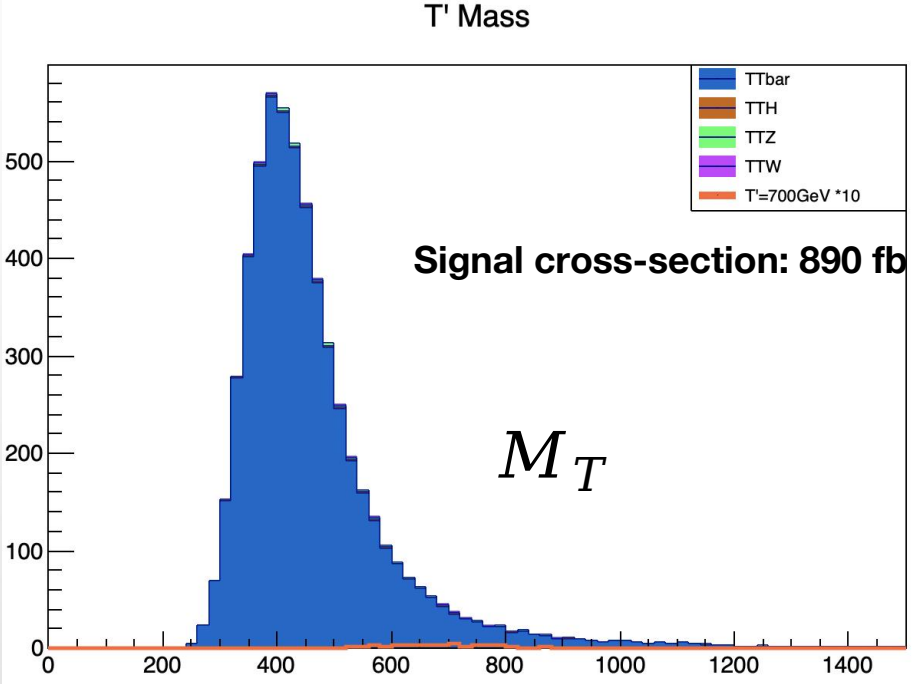
- **Cut0: Mu pair mass < 60GeV**
- **Cut1: Mu pair Pt + top pt > 350 GeV**
- **Cut2: Minimal delta R (mu, b jet from top) > 2**
- **Cut3: delta R (b jet from top, W from top) < 2.5**

We only have 1 major background: need 1 CR

N(GEN Signal)	N(Signal) 89fb	N(TT)	N(TTZ)	N(TTH)	N(TTW)	Signal Purity	Signal Efficiency	S/B
2.56	3.55	309	15	9	5	72%	37%	1.05%

TT Control Region

N(GEN Signal)	N(Signal)	N(TT)	N(TTZ)	N(TTH)	N(TTW)	TT/All
3.57	5.13	5662	40	30	19	98.4%



- Remove Cut1(Mu pair Pt + top pt > 350 GeV) for ttbar CR
  - Need to compare this shape with the SR shape
  - Other components are negligible in this CR
    - ttbar/All: 98.4%

$\tilde{M}_T$ plot will be added soon!