Search for Single Production of Vector-like Top Quark Decay Into Opposite Sign Dilepton Final State

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Abstract

As an extension of the standard model, the introduction of Vector Like Quarks provides a possible solution to various unsolved issues, such as the hierarchy problem. We present a search for the single production of the vector-like top quark T', in the following decay channel

- T' -> tH; t->Wb->qqb; H->WW->l+l-vv

The poster presents a cut-based event selection strategy designed with an MC study, followed by a T' reconstruction method based on the X^2 sorting algorithm and neutrino kinematic approximations. The current study is optimized for the di-muon channel at a T' mass of 700 GeV.
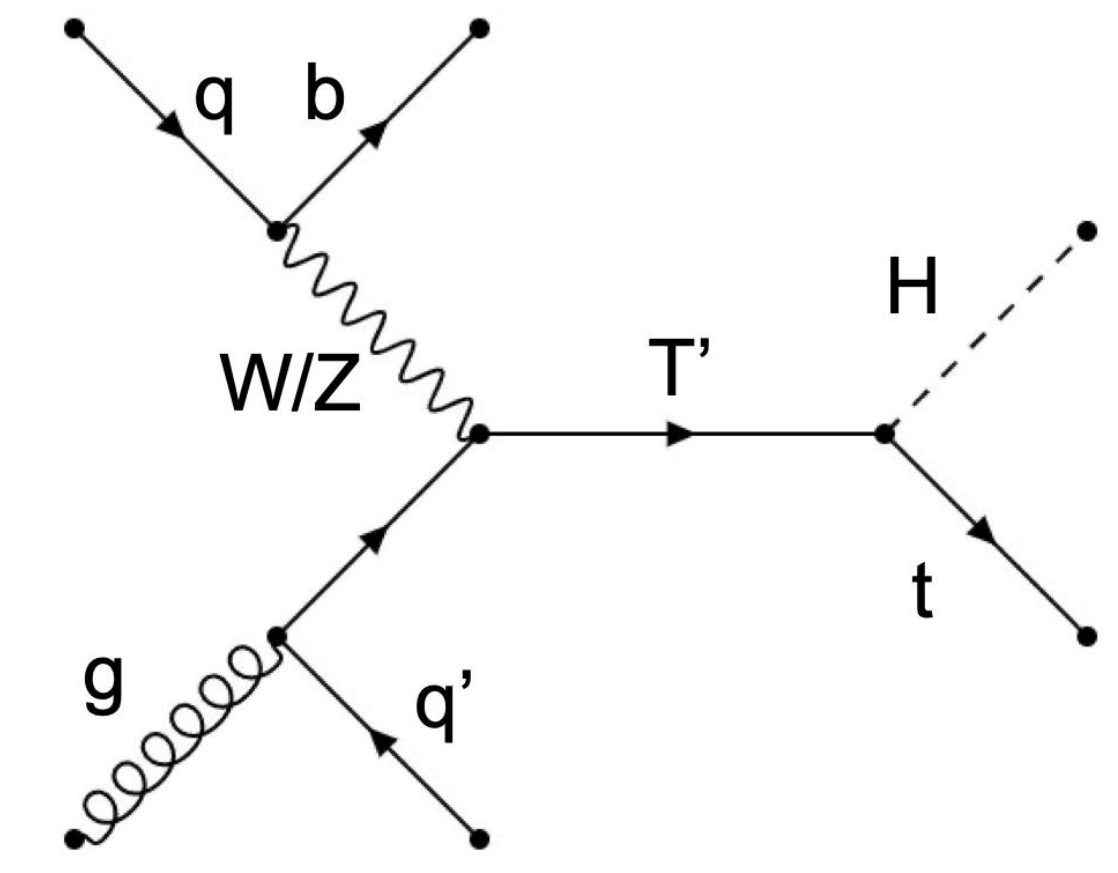
Event Reconstruction

- **top reconstruction**

  Select 3 jets (including 1 b jet) with X^2 sorting algorithm
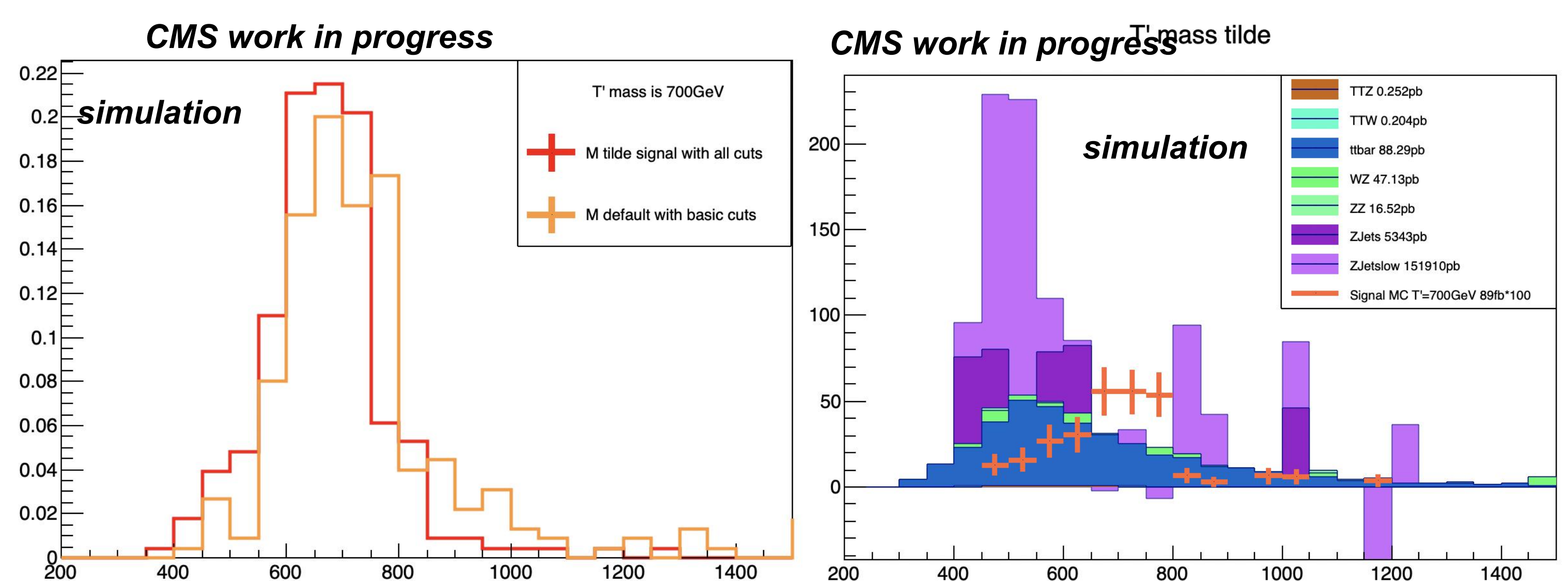
  $$X_W^2 = \frac{(m_W - m_{jj})^2}{\sigma_W^2} \qquad X_{top}^2 = \frac{(m_t - m_{bjj})^2}{\sigma_t^2}$$

- **Higgs reconstruction**
  - Decay products of boosted H decay are collimated assume that $\Theta_{ll} = \Theta_{\nu\nu}$
  - Invariant mass due to the neutrinos is obtained from GEN neutrino $m_{\nu\nu}$ from GEN information (Higgs->W->μ): 33GeV

- **Apply T' mass constraint**

  $$M_{\tilde{T}} = M_T - \sqrt{E_H^2 - \vec{p}_H^2} - \sqrt{E_{top}^2 - \vec{p}_{top}^2} + m_H^{pole} + m_{top}^{pole}$$

Events Selection Strategy

Main background processes for this channel are $t\bar{t}\ and\ DY$, other backgroud processes, such as ZZ, WZ, TTZ, are also considered
The cut-based strategy is optimised at T'mass on 700GeV

Basic selection & triggers

- For Muons
  - Two opposite sign muons
  - Pt > 20GeV
  - |eta| < 2.4
  - Tight Muon ID: Muon_tightId
  - Tight isolation: goodMuons_miniPFRelIso_all < 0.05
  - Significance cut: Muon_sip3d < 3
- For jets
  - Tight jet ID: Jet_jetId= 6
  - Pt > 30GeV
  - |eta| < 2.5
  - At least 3 good jets
  - At least 1 Loose B jet(goodJets_btagDeepFlavB>0.049)
  - Remove overlap jets. Overlap jet: min(dR(jet, mu)) < 0.4
- Triggers for 2018 dimuon channel:
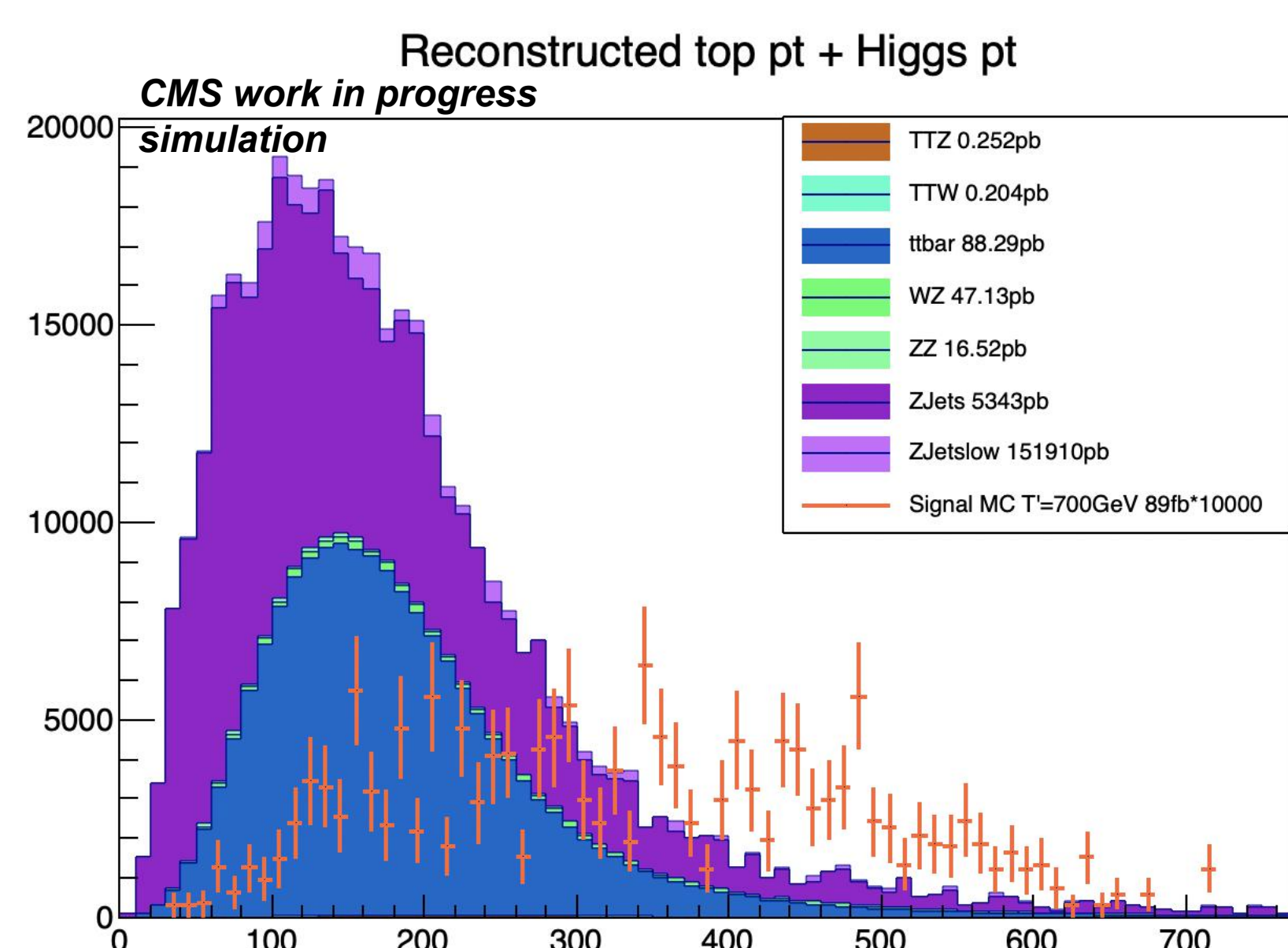 HLT_IsoMu24, HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL_DZ

Cut0: Mu pair mass < 60GeV

- Remove DY and ttbar while rejecting non-signal events from T' decay
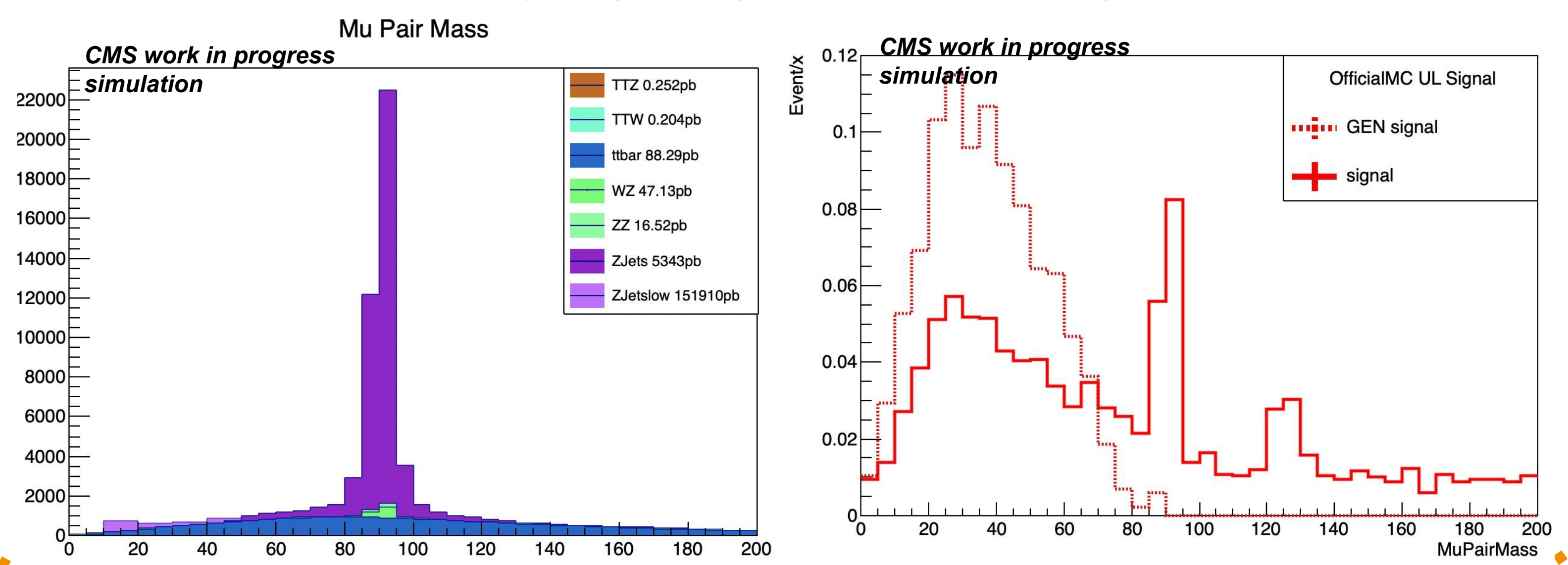
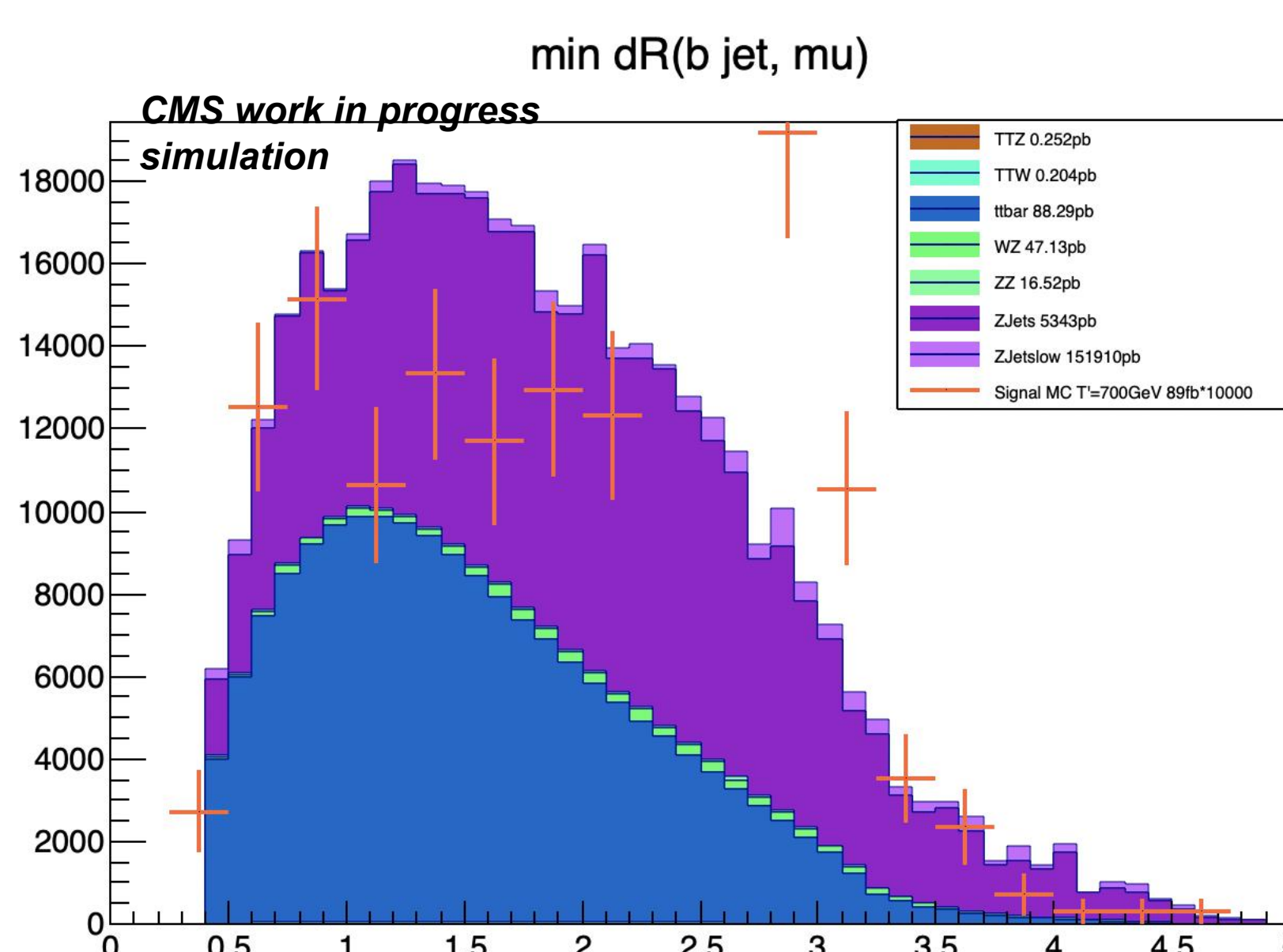### Cut1: Mu pair Pt + top pt > 350 GeV

- Reject all background: Objects from heavy T' decay has high pt

Cut2: Minimal delta R (mu, b jet from top) > 2

- Reject ttbar: Mu and b jet are from the same decay as in signal they are from different decays

Cut3: delta R (b jet from top, W from top) < 2.5

- Reject DY: b jet and W are close to each other in signal since they are from the same top decay and a very heavy mother particle

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