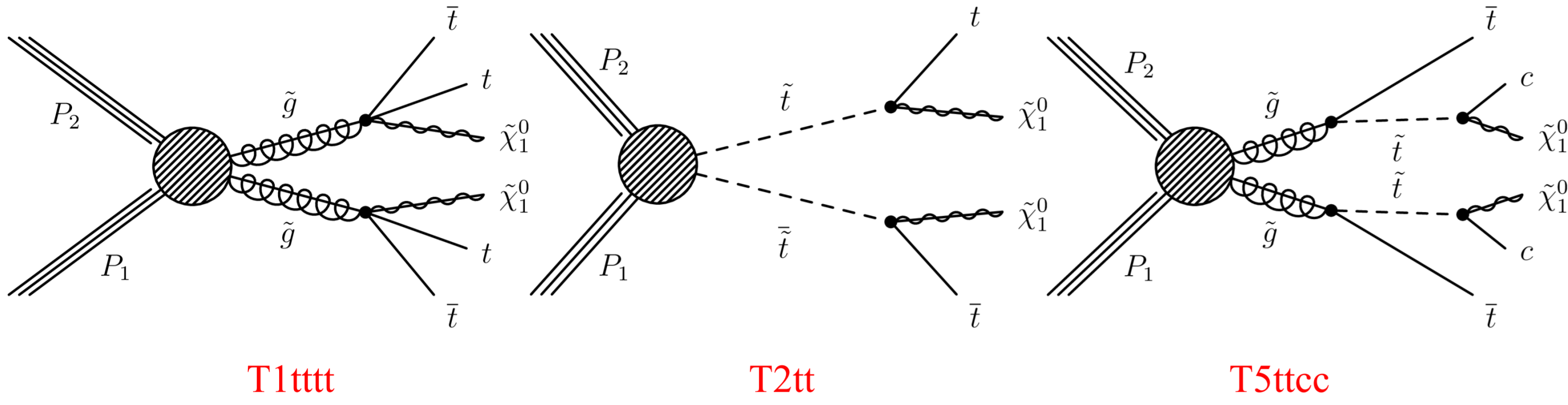


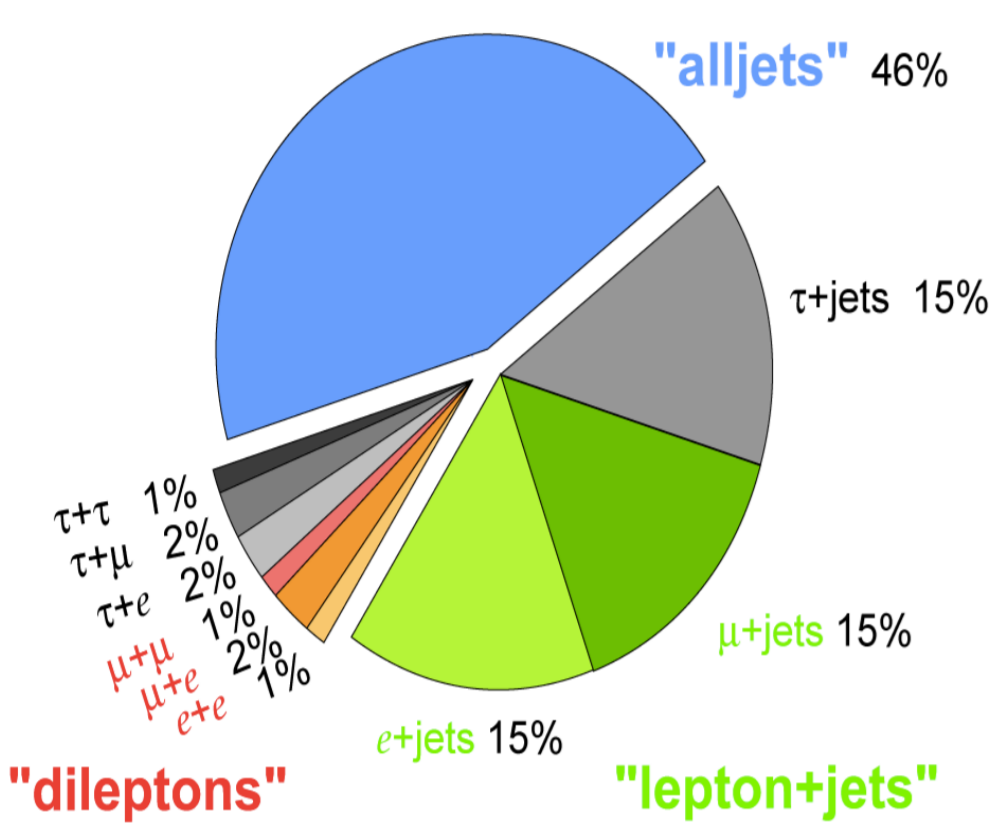
### Introduction

- Search for SUSY with MET+Jets+(Top-Jets) final states
- Interpretation on SUSY Simplified Models :

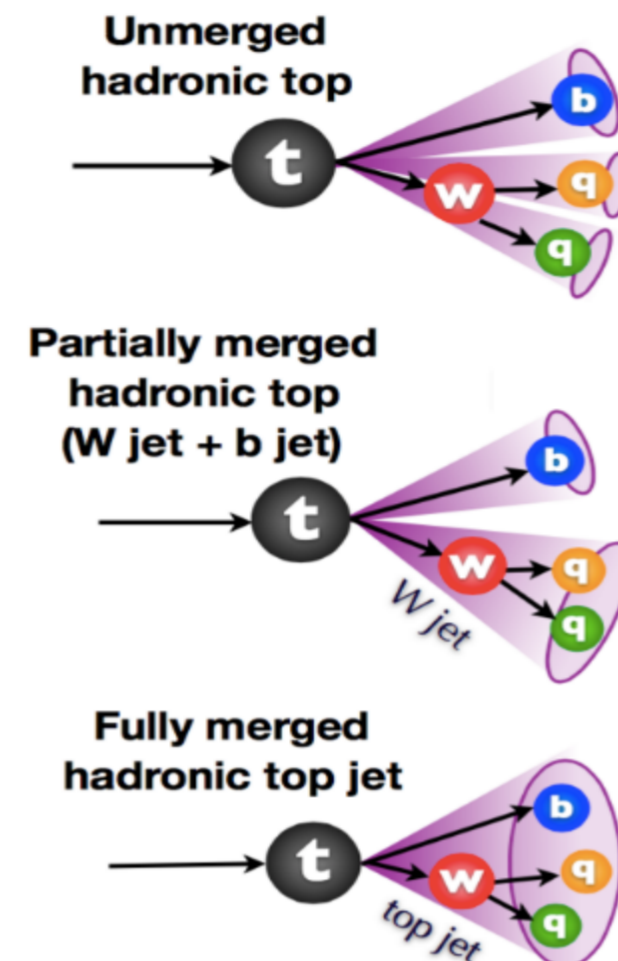


### Customized Top Tagger

#### Top Pair Branching Fractions



- Cut based Top Tagger on all jets decayed Tops
- Resolved Top : AK4 Tri-Jets combo in  $dR < 1.5$ ;  $m_{ij}/m_{ijk}$  in range of  $m_W/m_{Top}$
- Merged W case : AK4 jet mass in range [70,110], tag as W and then combine with at least 1 B-Jet
- Totally merged case : AK4 jet mass in range [110,220]



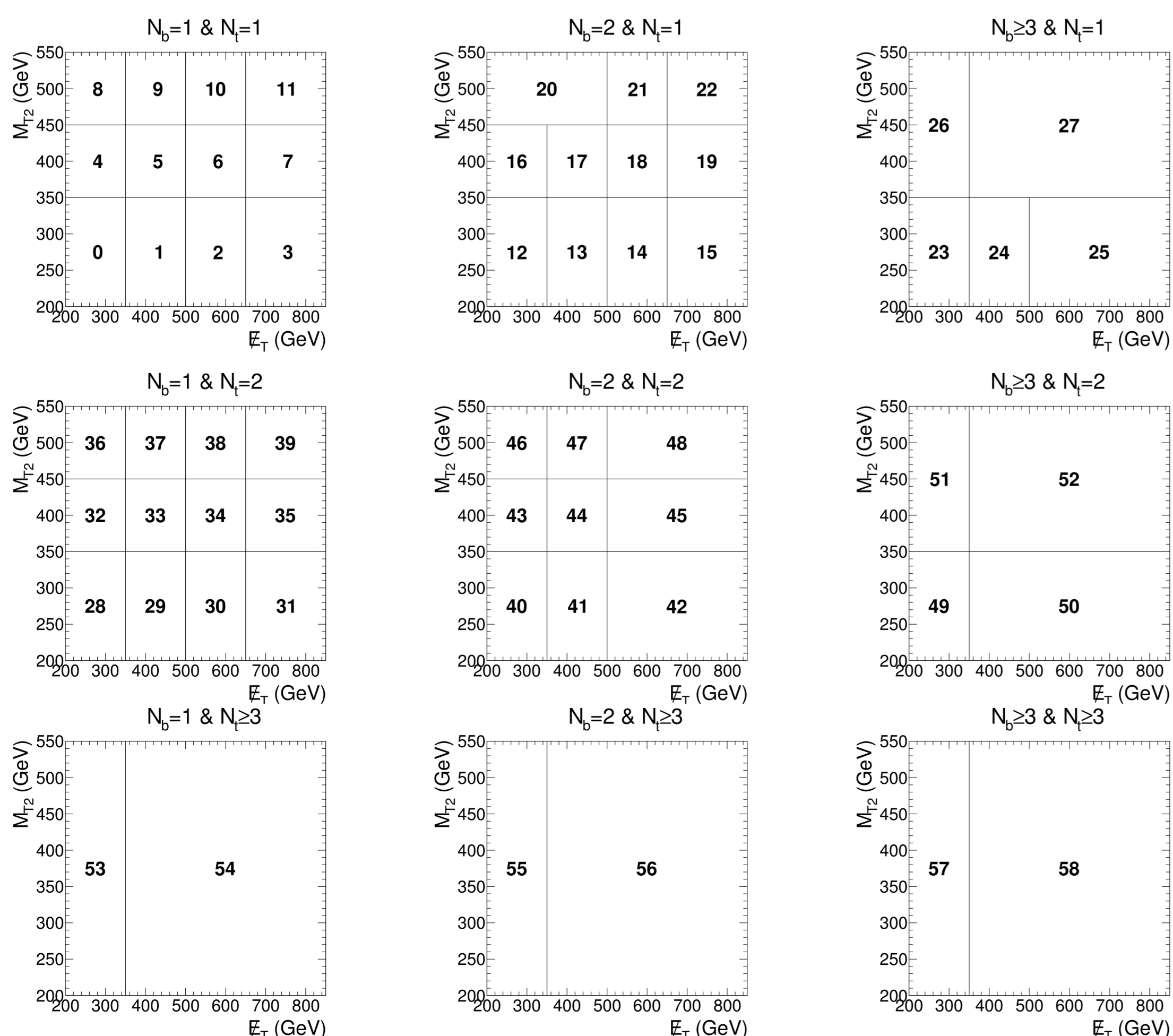
- Customized top tagger Performance : Efficiencies  $\sim 0.5$ , Fake Rate  $\sim 0.3$

### Event Selection

- Search Trigger:** `HLT_PFHT300_PFMET100_*`
- Noise cleaning:** `HBHENoiseFilter`, `HBHENoiseIsoFilter`, `EcalDeadCellTriggerPrimitiveFilter`, `GoodVertices`, `eeBadScFilter`, `CSCTightHalo2015Filter`
- Jet and  $E_T^{miss}$ :**
  - AK4PF jets with CHS:  $N_{Jets}^{50} \geq 2$  and  $N_{Jets}^{30} \geq 4$
  - $E_T^{miss} > 200$  GeV;  $H_T > 500$  GeV;  $N_{Bjets} \geq 1$  (CSVM);
  - $\Delta\Phi(jet_{1,2,3}, E_T^{miss}) > 0.5, 0.3, 0.3$
- Lepton Veto:**
  - $\mu$  veto: medium ID & miniISO;
  - $e$  veto: veto ID & miniISO;
  - IsoTrack:  $e/\mu$  track ( $relIso < 0.2$  &  $P_T > 5$  GeV) or  $\pi$  track ( $relIso < 0.1$  &  $P_T > 10$  GeV),  $M_{TW} < 100$  GeV
- Top Reconstruction:**
  - $N_{Top} \geq 1$  with Top tagger;  $M_{T2} > 200$  GeV;

### Search Bin Definition

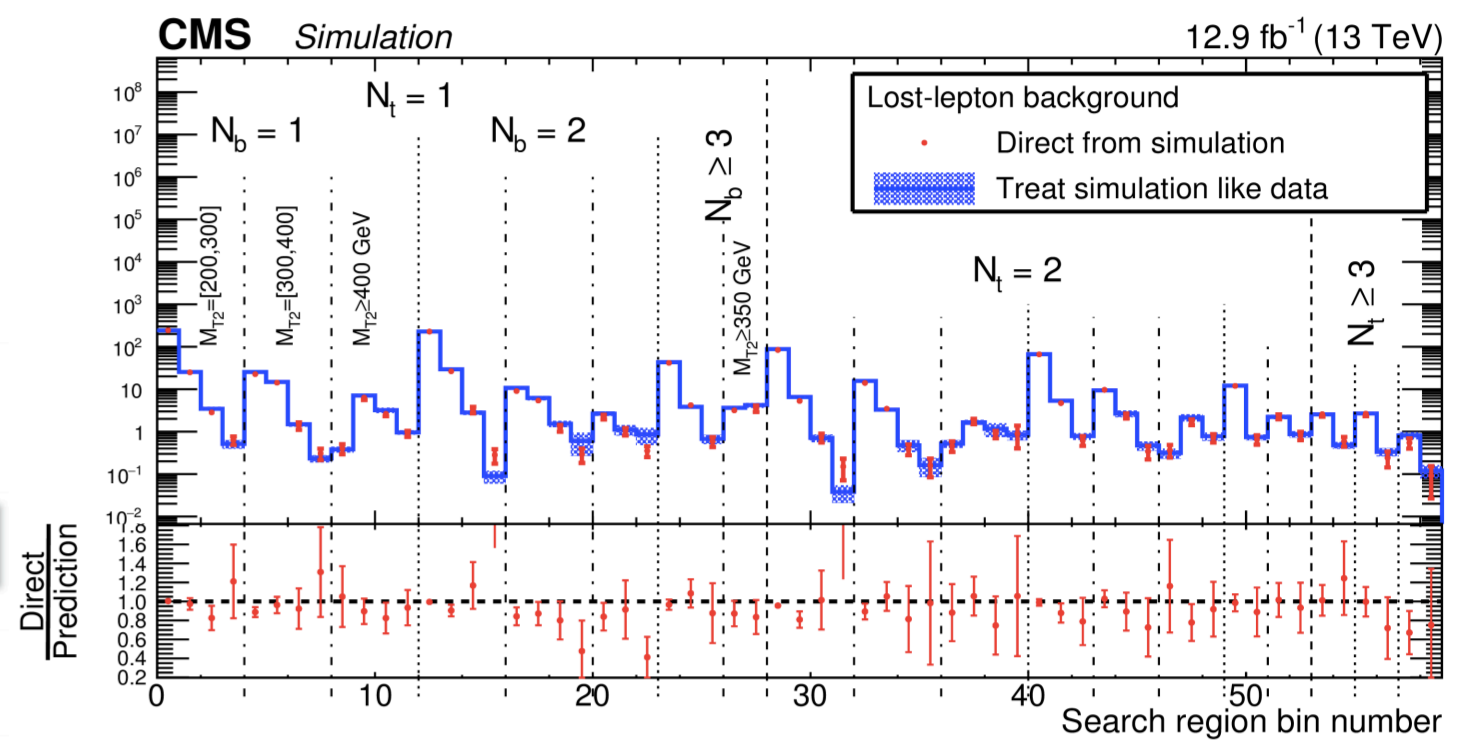
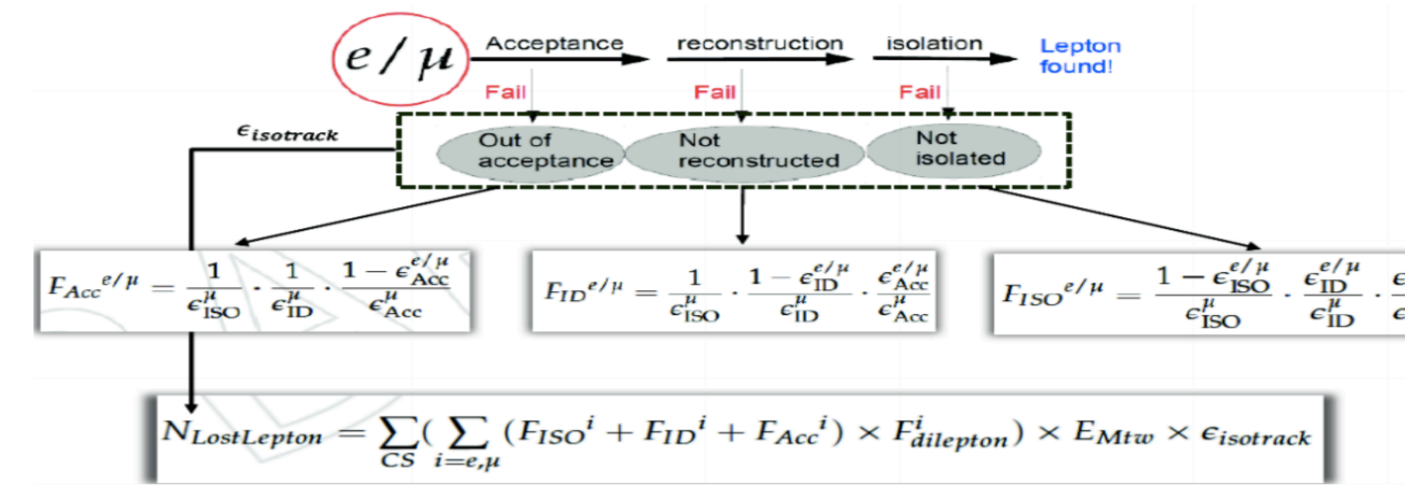
59 Search bins in  $N_{Bjets}, N_{Top}, M_{T2}, E_T^{miss}$  :



### Background Estimation

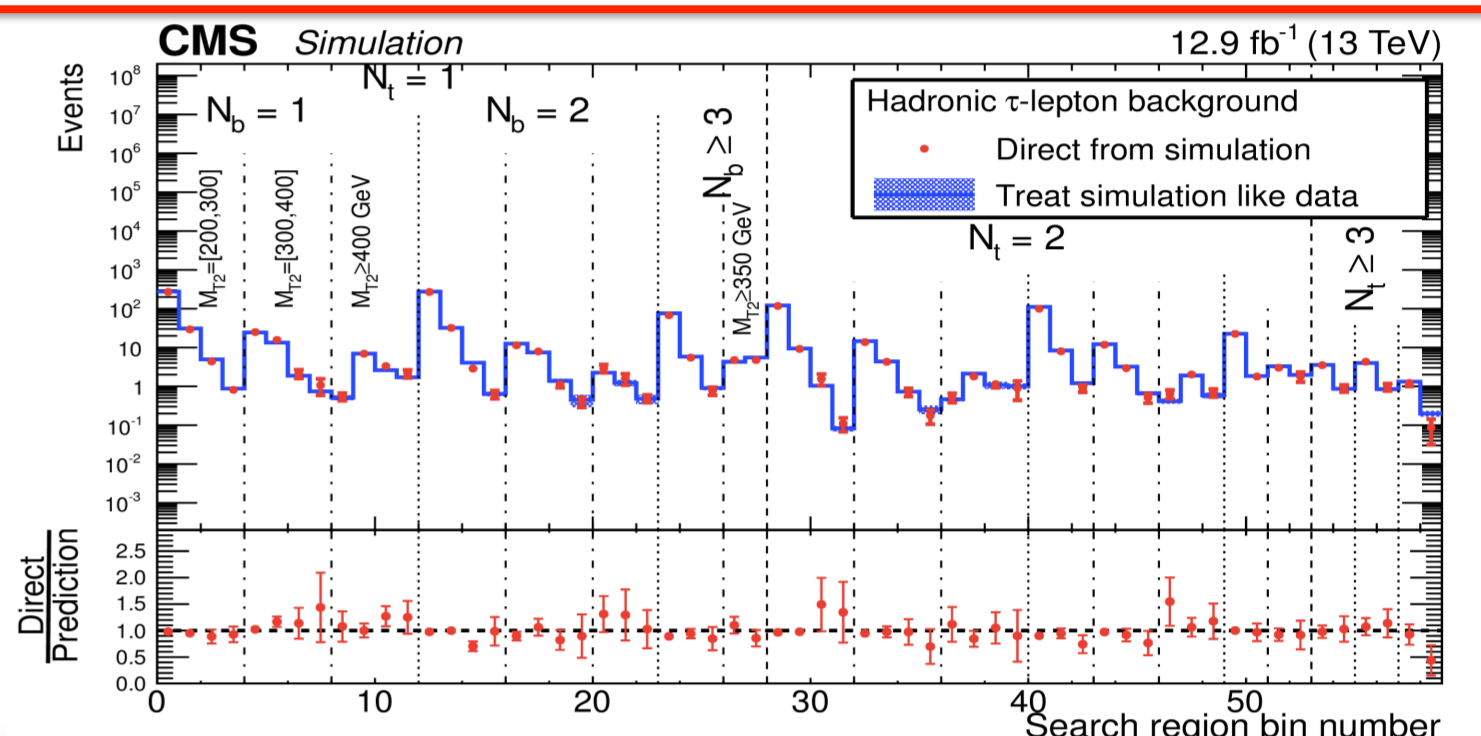
- TTJets/Wjets/Single Top : Lepton mis-identified as jet or Hadronically decayed Tau ( $\sim 70\%$ )
- Invisible Z : Z jets to neutrino ( $\sim 14\%$ )
- QCD : Multijet with fake missing  $E_T$  ( $\sim 8\%$ )
- Rare process : TTZ, TTW, Di-Boson, Tri-Boson, etc ( $\sim 8\%$ )

- Measure Muon Acceptance, Reconstruction Efficiencies and Isolation Efficiencies, Then Applied on Single Muon Control Sample in Data

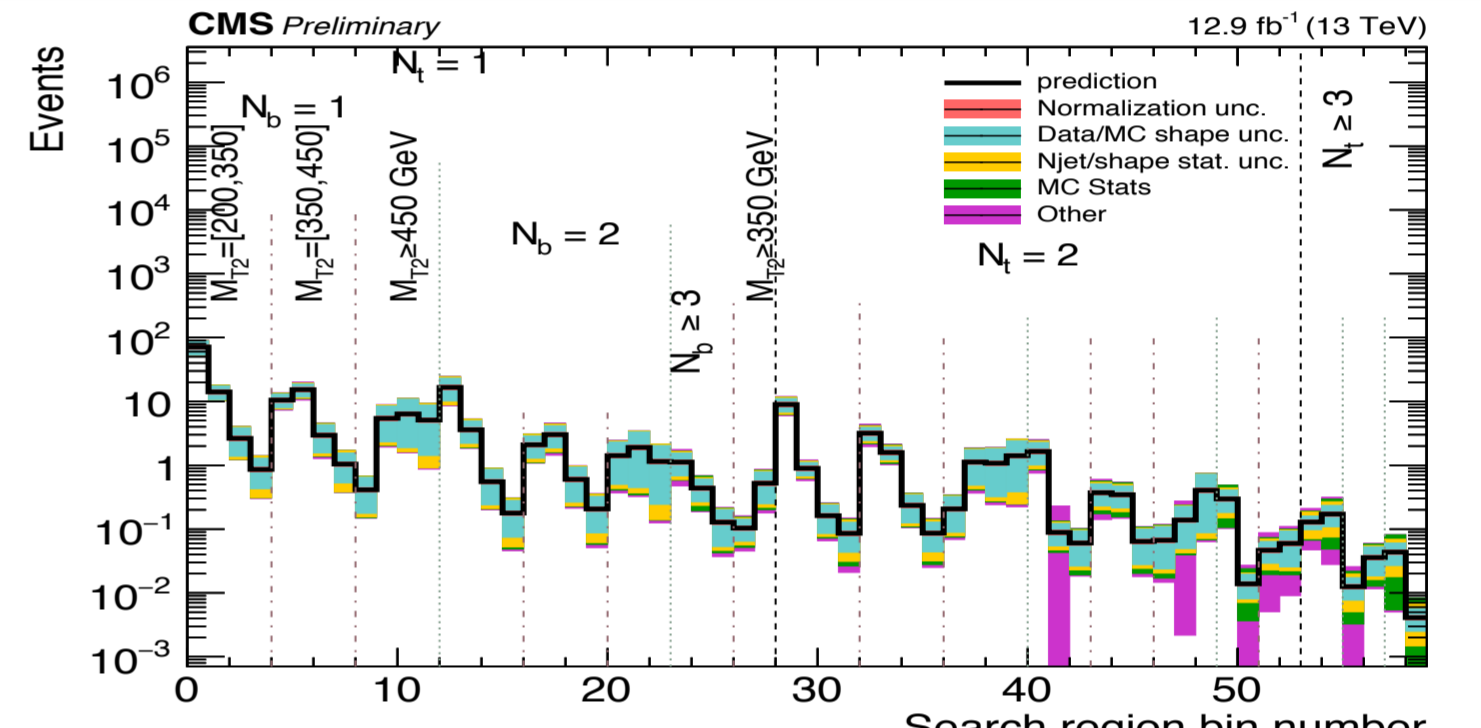
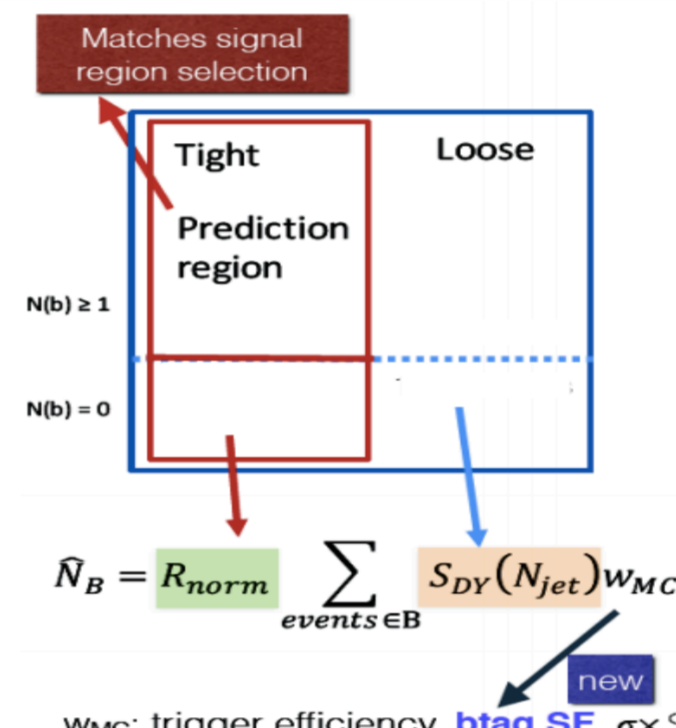


- Single  $\mu$  control sample with trigger: `HLT_Mu15_IsoVVVL_PFHT350_v*`
- Replace the  $\mu$  (from W) by a tau jet by using response template
- Recalculate all variables with the new tau jet

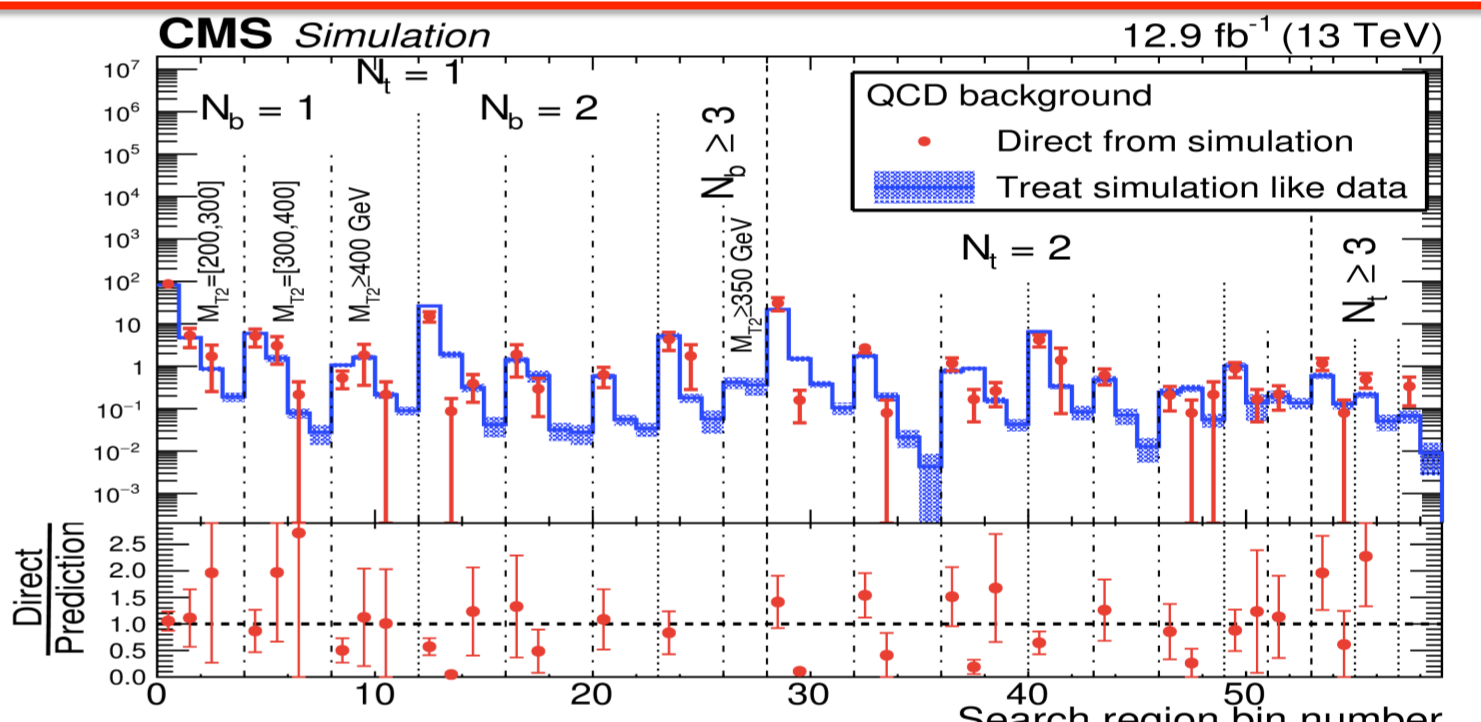
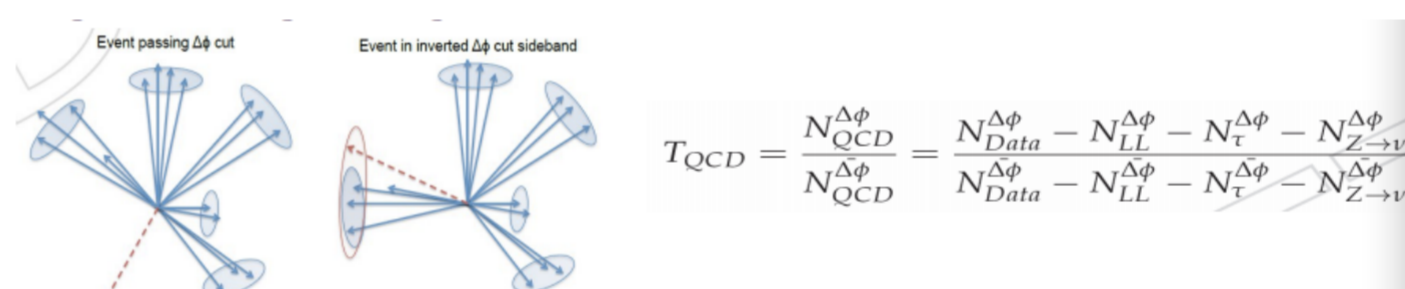
$$N_b = \sum_i \left( \sum_j (P_{ij}^{resp}) \frac{\epsilon_{T \rightarrow \mu} \epsilon_{reco} \epsilon_{acc} \epsilon_{iso} \epsilon_{trig}}{\epsilon_{trigger} \epsilon_{reco} \epsilon_{acc} \epsilon_{iso} \epsilon_{trig}} \frac{B(W \rightarrow \tau_b)}{B(W \rightarrow \mu)} \epsilon_{isotrack} F_{dilepton} \right)$$



- Loose selection: 4 jets, electron veto,  $\Delta\phi, H_T > 200$  GeV
- Tight selection: 4 jets, electron veto,  $\Delta\phi, H_T > 500$  GeV,  $E_T^{missing} > 200$  GeV,  $N_{Top} \geq 1, M_{T2} > 200$  GeV

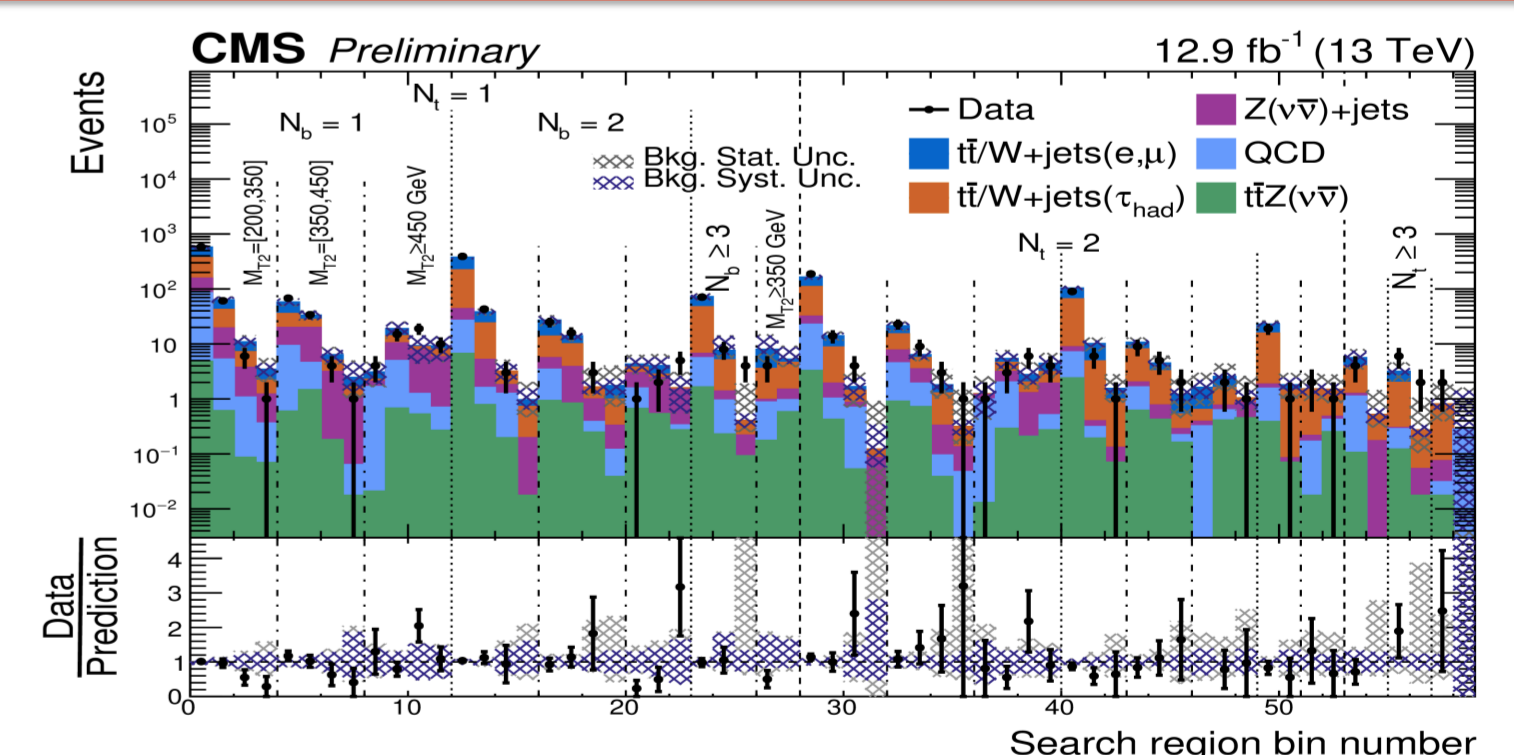


- QCD Translation factor : ratio of event yield signal region / Inverted  $\Delta\phi$  control region
- Inverted  $\Delta\phi$  control region : Baseline cut with  $\Delta\Phi(jet_{1,2,3}, E_T^{miss}) > 0.5, 0.3, 0.3$  inverted



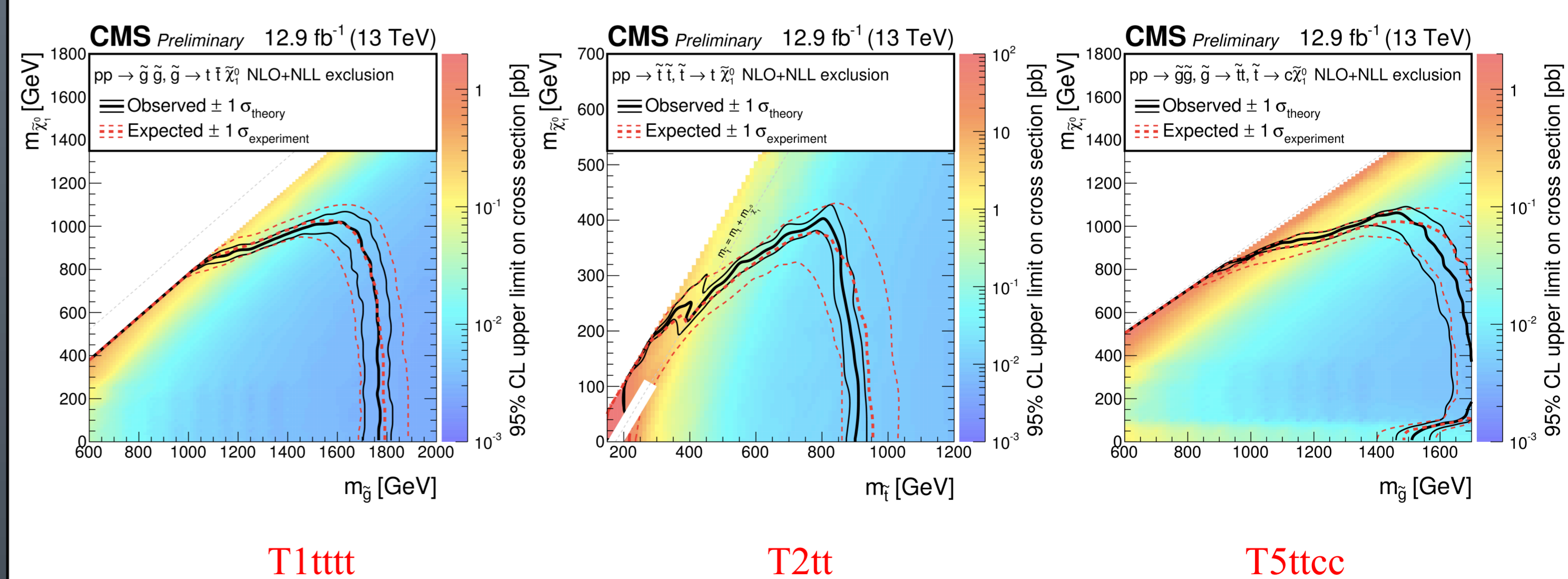
- MC based Method for Rare
- Expected to be a small contribution
- TTZ, TTW, Di-Boson, Tri-Boson
- Additional MC based PDF and scale uncertainty are included

- Background Estimation result in all search bin
- Data matches Prediction



### Interpretation

- Interpretation on SUSY Simplified Models : T1tttt, T2tt and T5ttcc



### Conclusion

- A search for supersymmetric particles decaying hadronically with at least 1 top quark is performed with 12.9 fb<sup>-1</sup> CMS Run 2 2016 data at 13 TeV
- No obvious SUSY signal excess observed