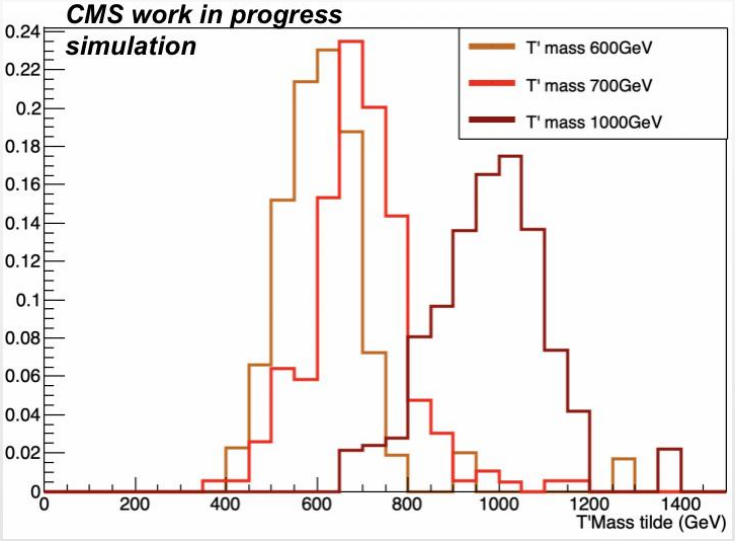
General Analysis Strategy

- **T'->tH; t->Wb->qqb; H->WW->l+l-vv**
  - **Cut-based strategy optimized at T'mass on 700GeV**
  - **Expected cross section(with NWA): 89fb**

- **Event Reconstruction**
  - **top reconstruction: Select 3 jets (including 1 b jet) with X^2 sorting algorithm**

$$\chi^2_W = \frac{(m_W - m_{jj})^2}{\sigma_W^2} \quad \chi^2_{top} = \frac{(m_t - m_{bjj})^2}{\sigma_t^2}$$

  - **Higgs reconstruction: Decay products of boosted H decay are collimated**
    - **Get p_z by assume $\theta_{ll} = \theta_{\nu\nu}$**
    - **Obtain $m_{\nu\nu}$ from neutrino GEN information**
  - **Apply T' mass constraint**
    - $\tilde{M_T} = M_T - \sqrt{E_H^2 - \vec{p}_H^2} - \sqrt{E_{top}^2 - \vec{p}_{top}^2} + m_H^{pole} + m_{top}^{pole}$



- **Events Selection**
  - **Main background processes are $t\bar{t}$ and DY, other background processes (ZZ, WZ, TTV) are also considered**

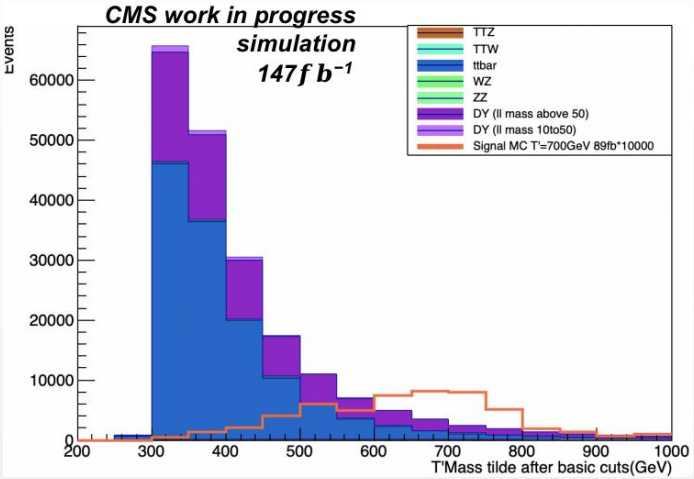
MC Samples

- Take MC sample for analysis strategy study
  - All Nano AOD samples are lastest reconstructed (UL v9)

T'(700) Signal	TprimeBToTH_M-700_LH_TuneCP5_13TeV-madgraph_pythia8	0.089 pb-1
TTbar	TTTo2L2Nu_TuneCP5_13TeV-powheg-pythia8	88.29 pb-1
DY(m(ll) > 50GeV)	DYJetsToLL_M-50_TuneCP5_13TeV-amcatnloFXFX-pythia8	6435.0 pb-1
DY(10GeV<m(ll)<50GeV)	DYJetsToLL_M-10to50_TuneCP5_13TeV-amcatnloFXFX-pythia8	20460.0 pb-1
W+jets	WJetsToLNu_TuneCP5_13TeV-madgraphMLM-pythia8	
TTW	ttWJets_TuneCP5_13TeV_madgraphMLM_pythia8	0.204 pb-1
TTZ	ttZJets_TuneCP5_13TeV_madgraphMLM_pythia8	0.252 pb-1
WZ	WZTo3LNu_TuneCP5_13TeV-amcatnloFXFX-pythia8	47.13 pb-1
ZZ	ZZ_TuneCP5_13TeV-pythia8	16.52 pb-1

Cut Strategy

- **Basic cuts& triggers**
  - Triggers for dimuon channel: HLT_IsoMu24, HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL
  - For Muons
    - Two opposite sign muons
    - p_T > 20GeV, $|\eta|$ < 2.4
    - Tight Muon ID: Muon_tightId
    - Tight isolation: goodMuons_miniPFRelIso_all < 0.05
    - Significance cut: Muon_sip3d < 3
  - For jets
    - p_T > 30GeV, $|\eta|$ < 2.5
    - At least 3 tight ID jets, including 1 medium B jet
    - Remove overlapped jets

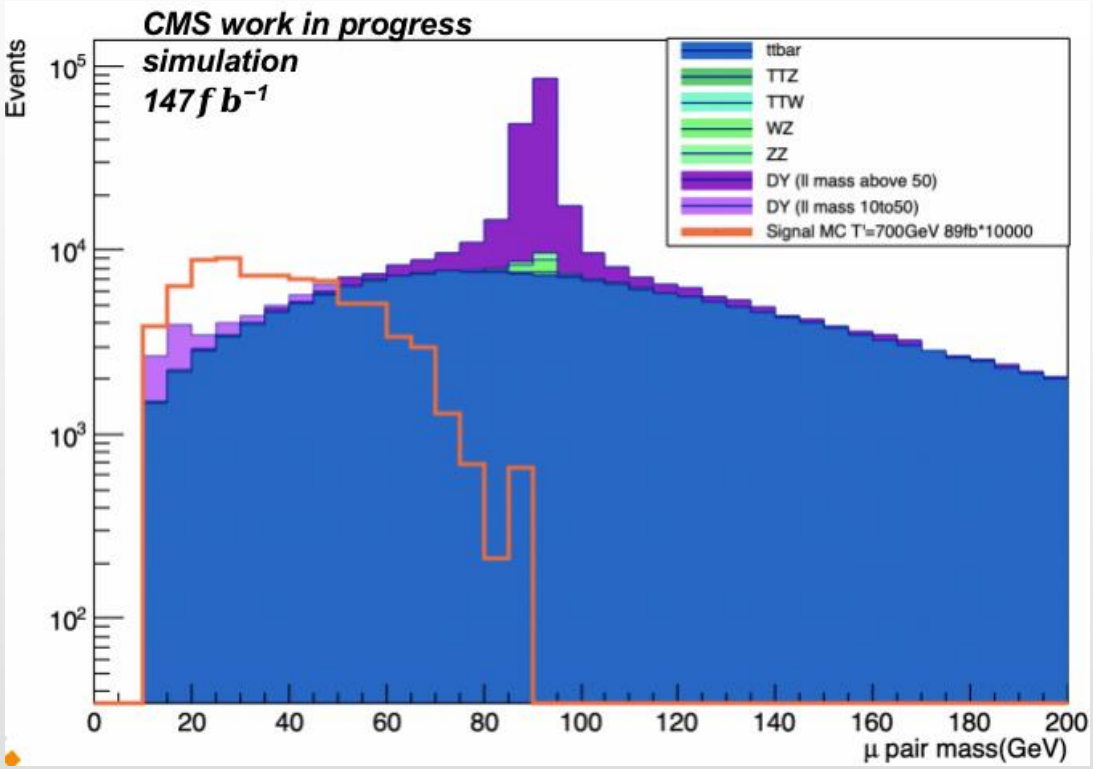


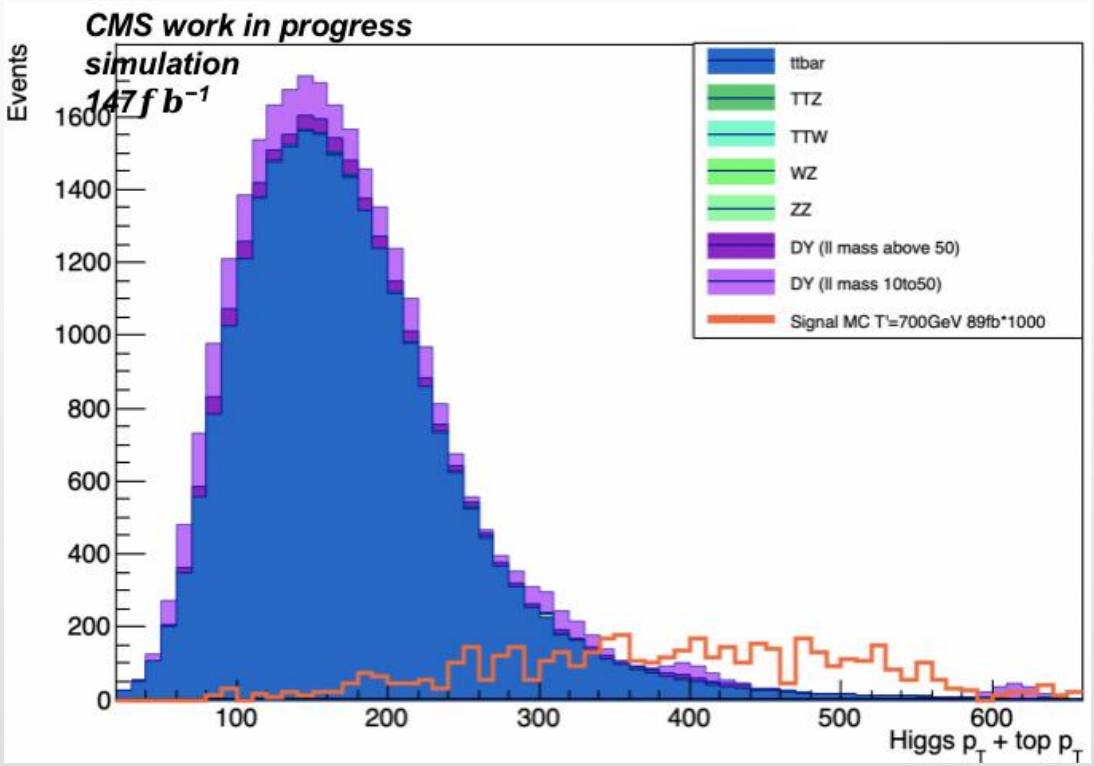
Cuts	N_Signal	signal eff	N_TT	N_DY50	N_DY10to50	N_TTW	N_TTZ	N_ZZ	N_WZ	S/B
basic cuts	5.29	100%	129992	67558	2613	136	500	636	1329	0.0026%
cut0	4.62	87%	25099	755	2613	21	37	17	65	0.016%
cut1	2.87	54%	789	75	302	3	7	3	28	0.23%
cut2	2.48	46%	272	65	249	1	5	1	16	0.41%
cut3	2.11	39%	186	7	47	1	4	0.7	4	0.84%

- **Main cuts**
  - μ pair mass < 60GeV
  - μ pair p_T + top p_T > 350 GeV
  - Minimal δR (μ, b jet from top) > 2
  - δR (b jet from top, W from top) < 2.5

Cut Strategy

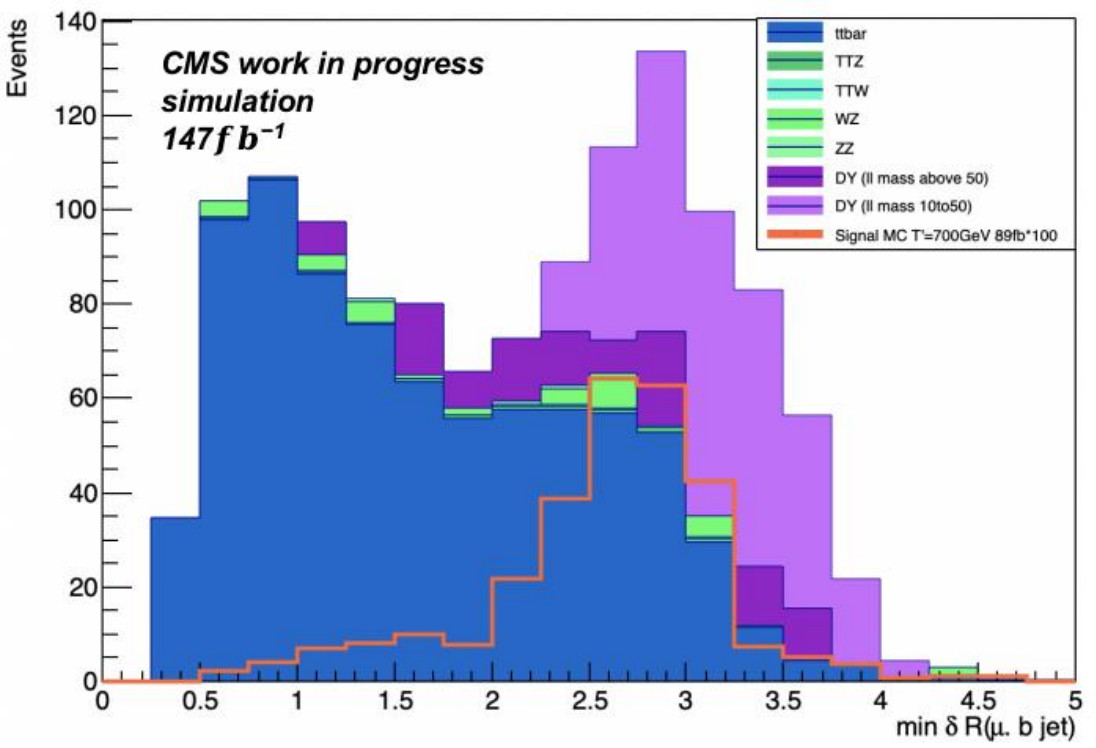
- **Cut0: Mu pair mass < 60GeV**
  - **Remove DY, $t\bar{t}$ and non-signal T' decay**
- **Cut1: Mu pair Pt + top pt > 350 GeV**
  - **Reject all background: high $\mathbf{p_T}$ objects from heavy T' decay in signal process**

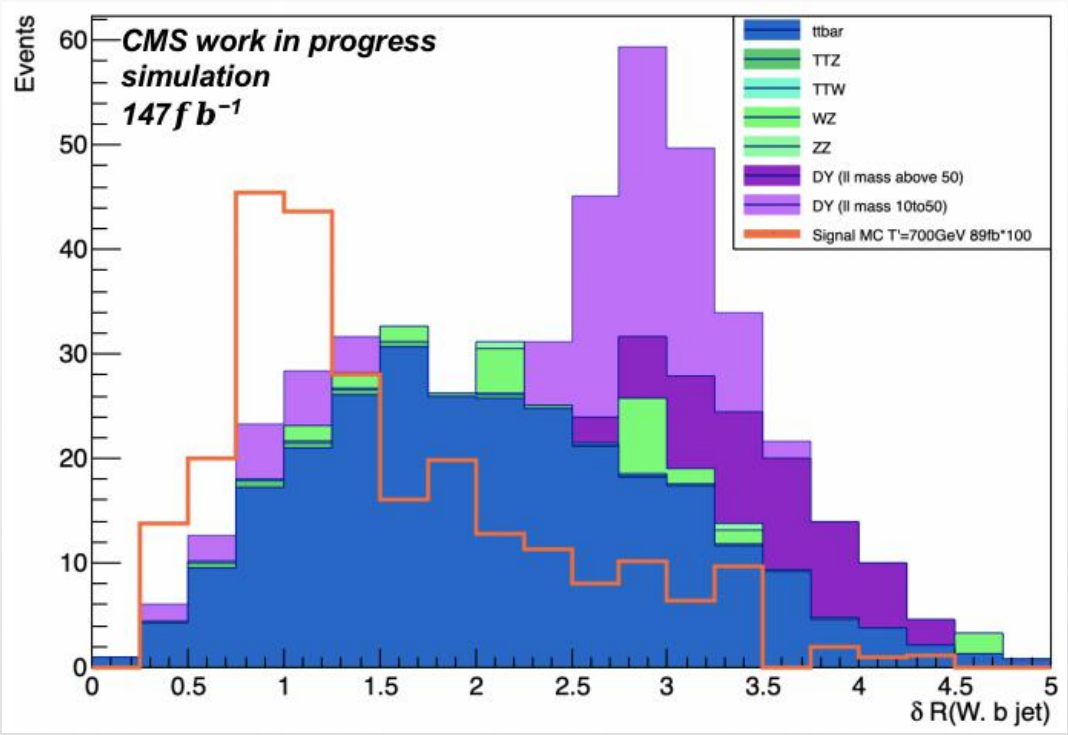




Cut Strategy

- **Cut2: min δR (μ, b jet from top) > 2**
  - **Reject $t\bar{t}$: μ & b jet are from the same decay in $t\bar{t}$**
- **Cut3: δ R (b jet, W) < 2.5**
  - **Reject DY: b jet and W from different decays in DY**





Cut Strategy

- $\tilde{M_{T'}}$ distribution after all selection: Peaking signal on falling background spectrum
  - Limited statistics of DY NLO sample -> fluctuations

Cuts	N_Signal	signal eff	N_TT	N_DY50	N_DY10to50	N_TTW	N_TTZ	N_ZZ	N_WZ	S/B
basic cuts	5.29	100%	129992	67558	2613	136	500	636	1329	0.0026%
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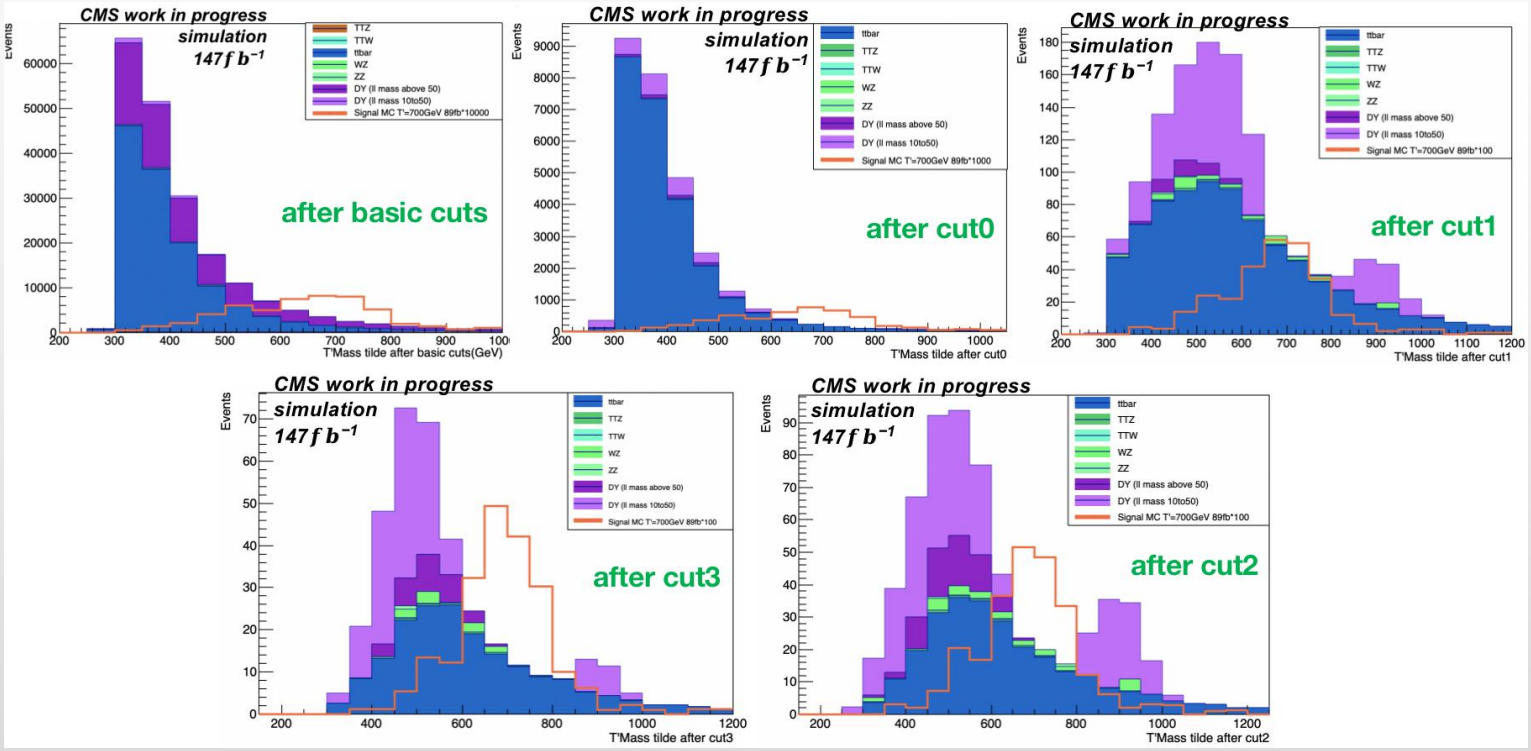
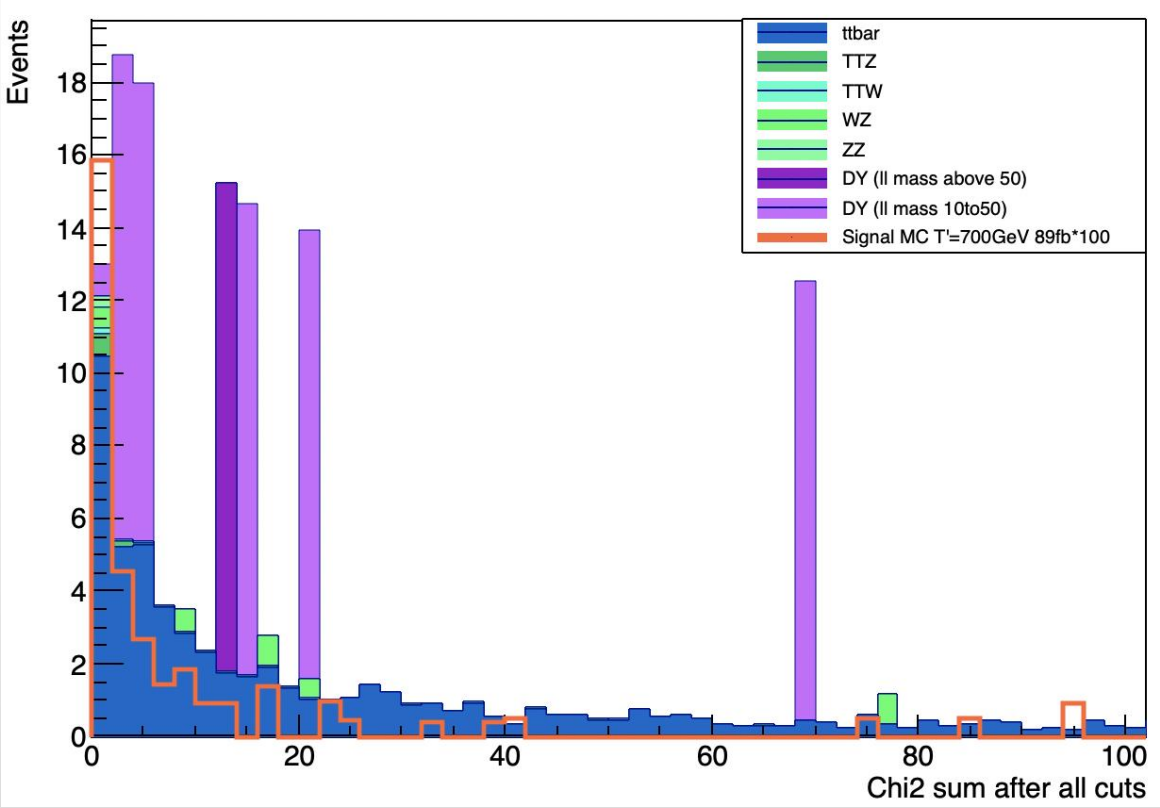


Cannot remove all Z+jets in my channel

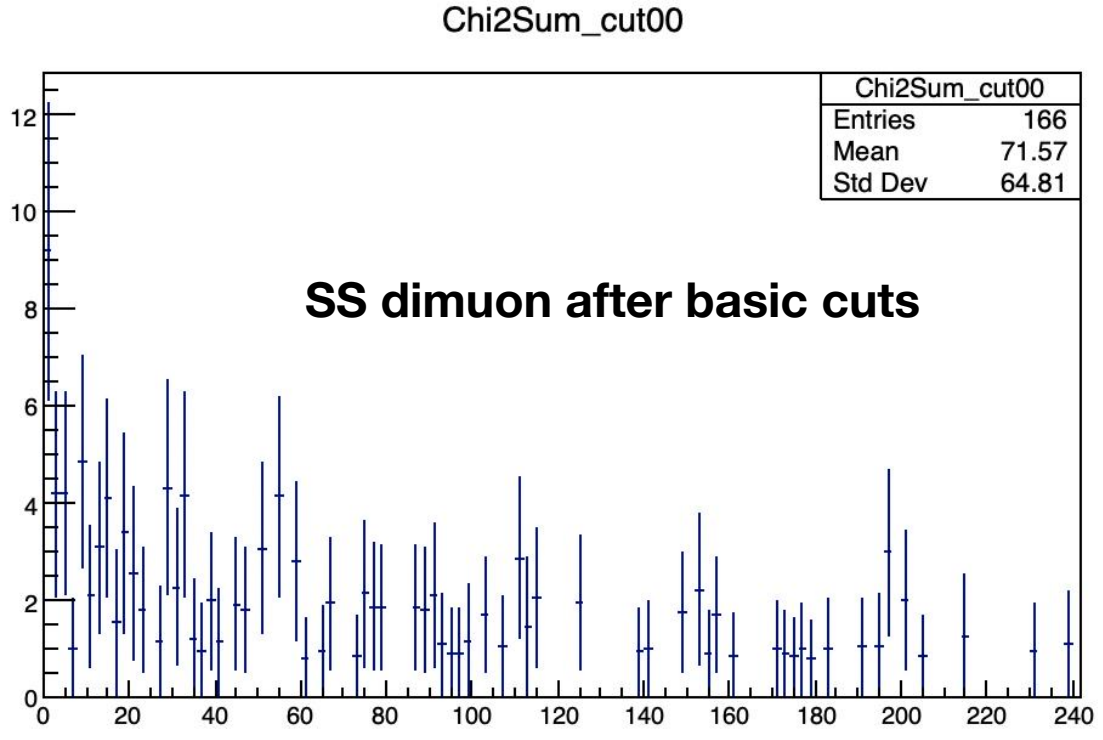
- **Cutting on low Chi2 sum value (like 5 GeV) will kill too much background**
  - **Still cannot remove all Z+jets**
  - **60 events for 18 all: might ruin the failing spectrum, bing long error bars and fitting difficulty**

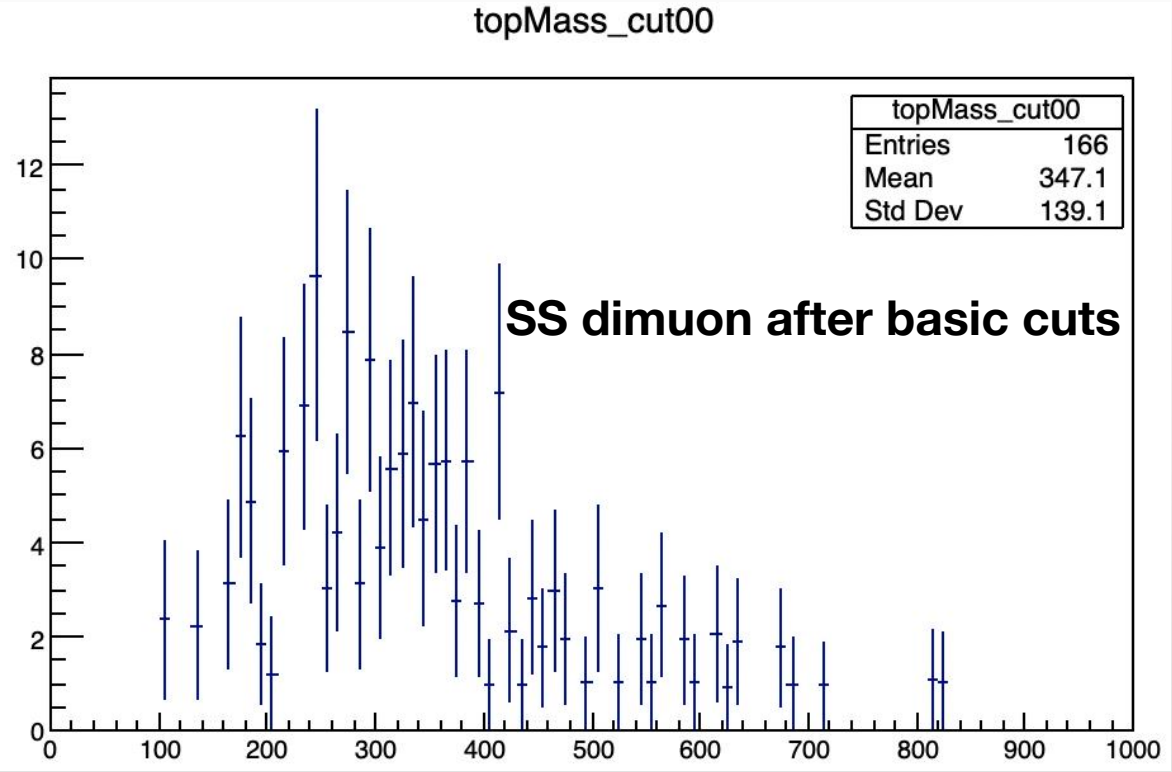
- ***My personal opinion (maybe not right): Chi2 cut is just a mass window cut with higher accuracy. We can not say the selected jets are from a real top just because they passed the Chi2 cut***



Cannot remove all Z+jets in my channel

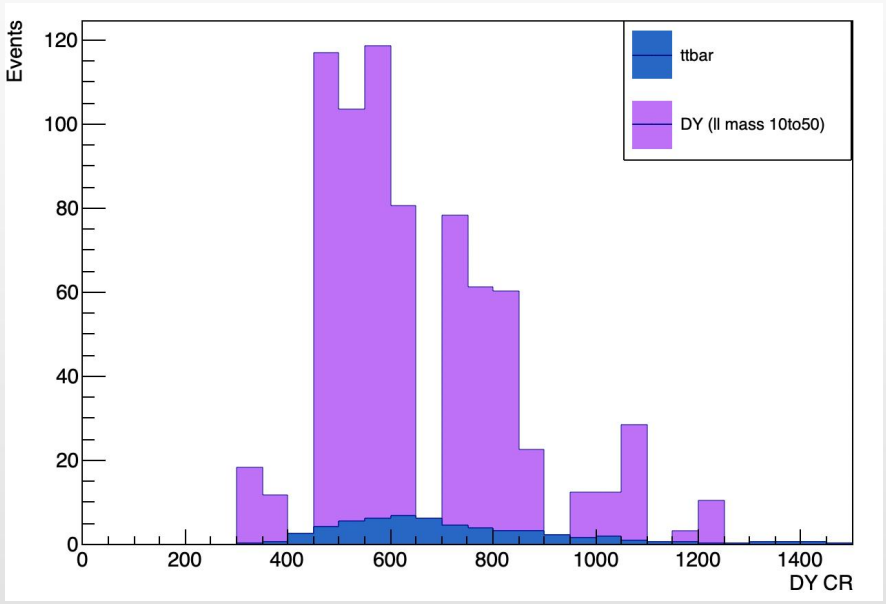
- **Cross check with SS dilepton channel**
  - **There is NO hadronic decay top in this channel: We don't see any top peak in m(bjj) distribution**
  - **But we still see some events with low Chi2 value**

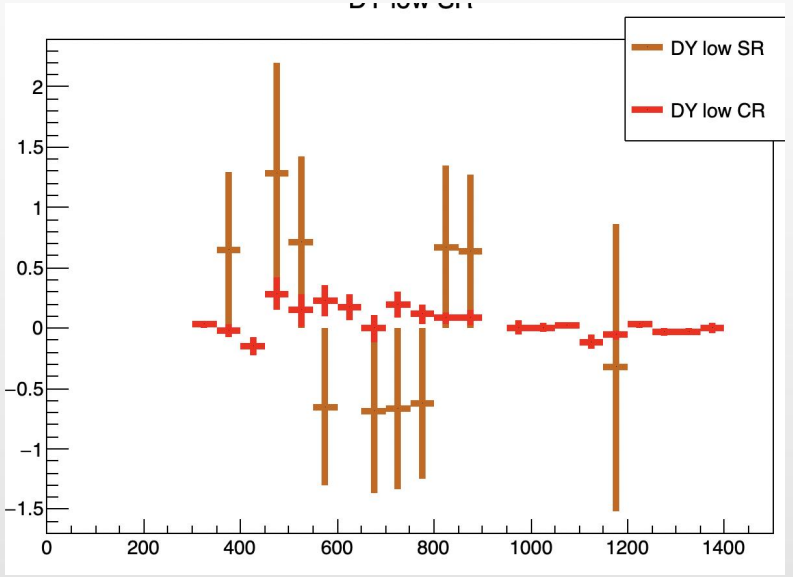




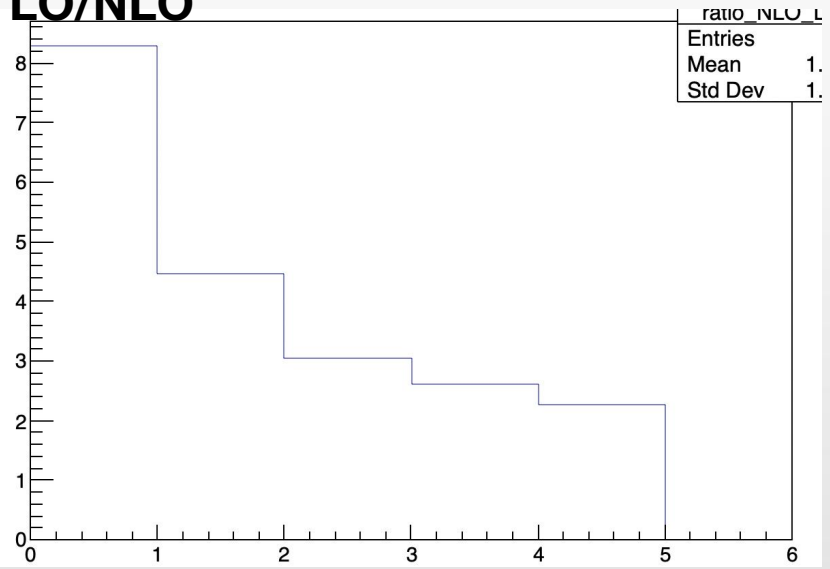
DY CR test

- **DY CR: Require b jet number = 0, MET_Pt < 100 GeV**
- **ttbar and signal are highly compressed**
- **Still need to slove DY MC shortage issue**
  - **NLO events has more jets**





LO/NLO



N jets

Some ideas about what to do next

- If we would like to import high mass T' (> 850GeV) to our analysis
  - Need to study boosted category
    - Resolved top will become a single top jet
    - Will use non-iso triggers and tags
      - Other analysis and I find Iso trigger will reduce high mass signal efficiency
    - Will keep iso triggers and tags for 700GeV analysis: To keep low pt muons
- Find a solution for DY MC shortage issue
- Find CR and use data driven method for DY, and simulation for ttbar and others
  - Test DY CR
- Add ee channel and emu channel