

B tag study

➤ Study some b-tag related cut strategy

- Cut1: Basic cuts(medium b tag) $\&\& \Delta R(\mu^+, \mu^-) < 1$ $\&\& \Delta R(\mu^+, \text{medium b jet}) > 1.5$ $\&\& \Delta R(\mu^+, \text{medium b jet}) > 1.5$ $\&\& HT > 300$ $\&\& \mu \text{ pair pt} > 140$ $\&\& 70 < \text{non-b (medium) jet pair mass} < 100$
- Cut2: Basic cuts(loose b tag) $\&\& \Delta R(\mu^+, \mu^-) < 1$ $\&\& \Delta R(\mu^+, \text{loose b jet}) > 1.5$ $\&\& \Delta R(\mu^+, \text{loose b jet}) > 1.5$ $\&\& HT > 300$ $\&\& \mu \text{ pair pt} > 140$ $\&\& 70 < \text{non-b (loose) jet pair mass} < 100$
- Cut3: Basic cuts(medium b tag) $\&\& \Delta R(\mu^+, \mu^-) < 1$ $\&\& \Delta R(\mu^+, \text{medium b jet}) > 1.5$ $\&\& \Delta R(\mu^+, \text{medium b jet}) > 1.5$ $\&\& HT > 300$ $\&\& \mu \text{ pair pt} > 140$ $\&\& 70 < \text{jet pair mass} < 100$
- Cut4: Basic cuts(loose b tag) $\&\& \Delta R(\mu^+, \mu^-) < 1$ $\&\& \Delta R(\mu^+, \text{loose b jet}) > 1.5$ $\&\& \Delta R(\mu^+, \text{loose b jet}) > 1.5$ $\&\& HT > 300$ $\&\& \mu \text{ pair pt} > 140$ $\&\& 70 < \text{jet pair mass} < 100$

➤ Basic cuts:

- Cuts for muons
 - Tight ID cut: Muon_tightId
 - $Pt(\mu) > 20\text{GeV}$
 - $|\eta| < 2.4$
 - Tight isolation cut: goodMuons_miniPFRelIso_all < 0.05
- Cuts for jets
 - Tight jet ID cut: Jet_jetId: 6
 - $Pt(\text{jet}) > 30\text{GeV}$
 - $|\eta| < 2.5$
- Cuts for events
 - 1 OS muon pair
 - At least 3 jets
 - At least 1 b jet
 - Loose/ medium b-tag jet: goodJets_btagDeepFlavB >0.2783)

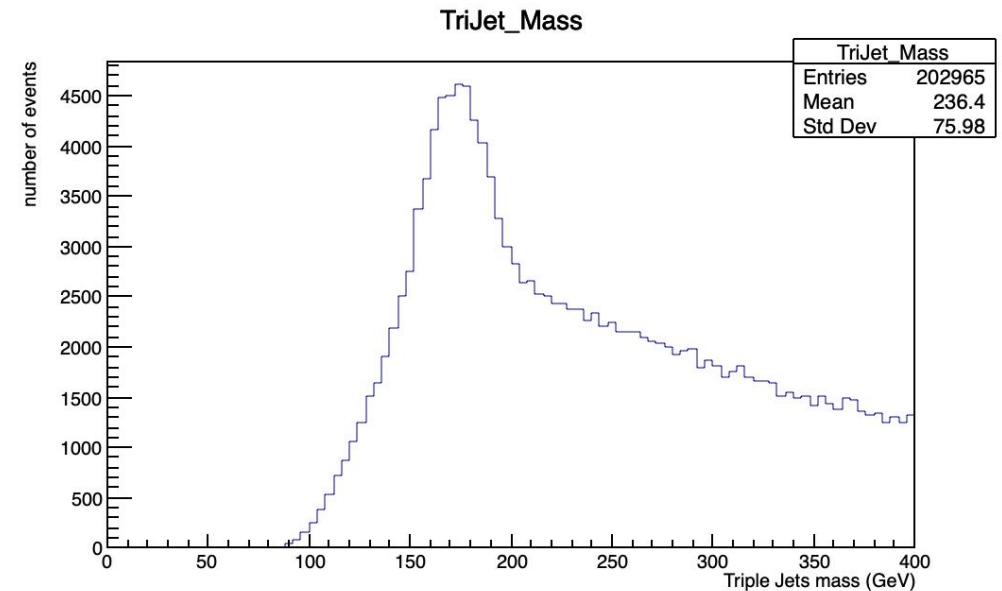
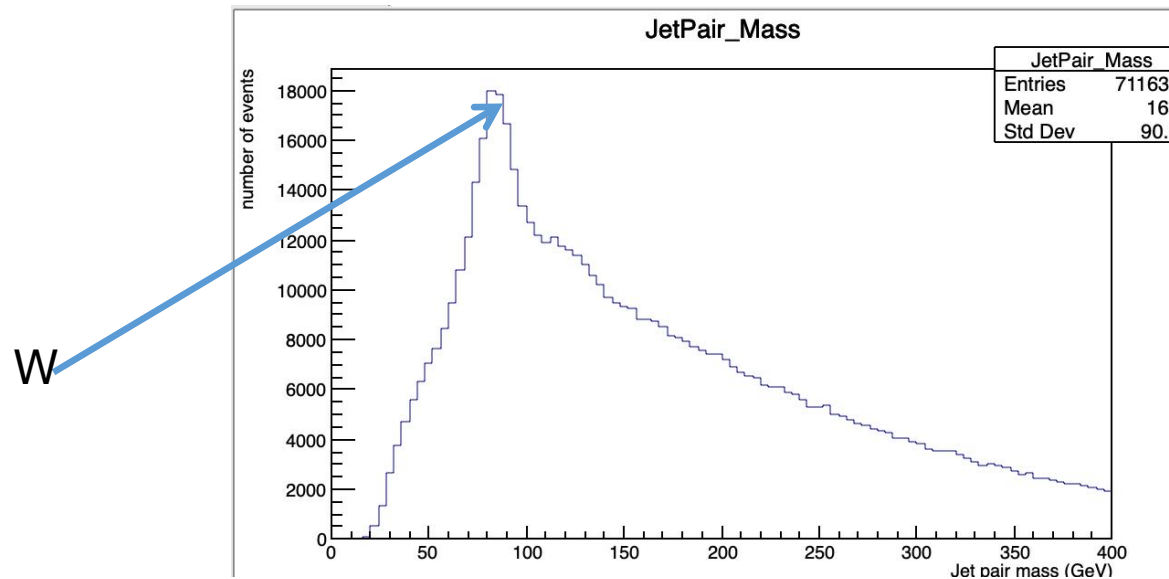
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➤ After cut 1:

- Basic cuts (medium b tag) && $\Delta R(\mu^+, \mu^-) < 1$ && $\Delta R(\mu^+, \text{medium b jet}) > 1.5$ && $\Delta R(\mu^+, \text{medium b jet}) > 1.5$ && $HT > 300$ && $\mu \text{ pair pt} > 140$ && $70 < \text{non-b (medium) jet pair mass} < 100$

Let's choose
this one?

	Number of TT events (after scaling)	Number of Signal events (after scaling)	Ratio S/B_tt
Cut 1	206.25	2.458	1.192%

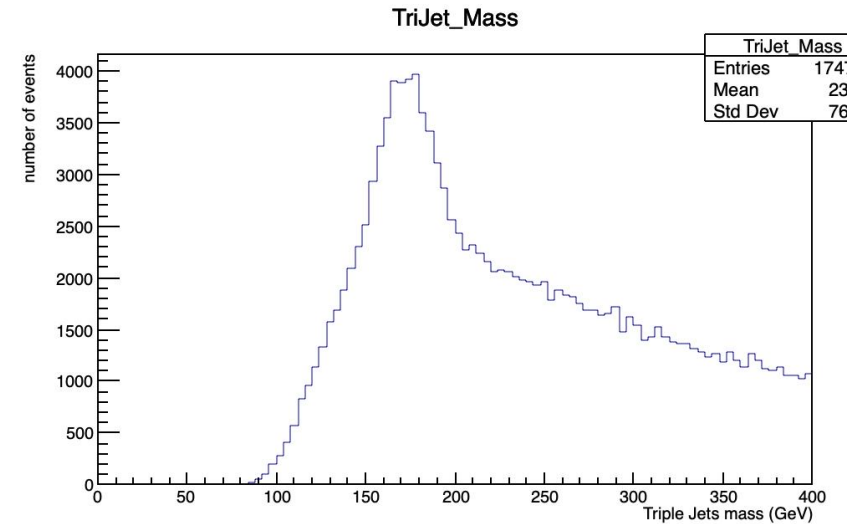
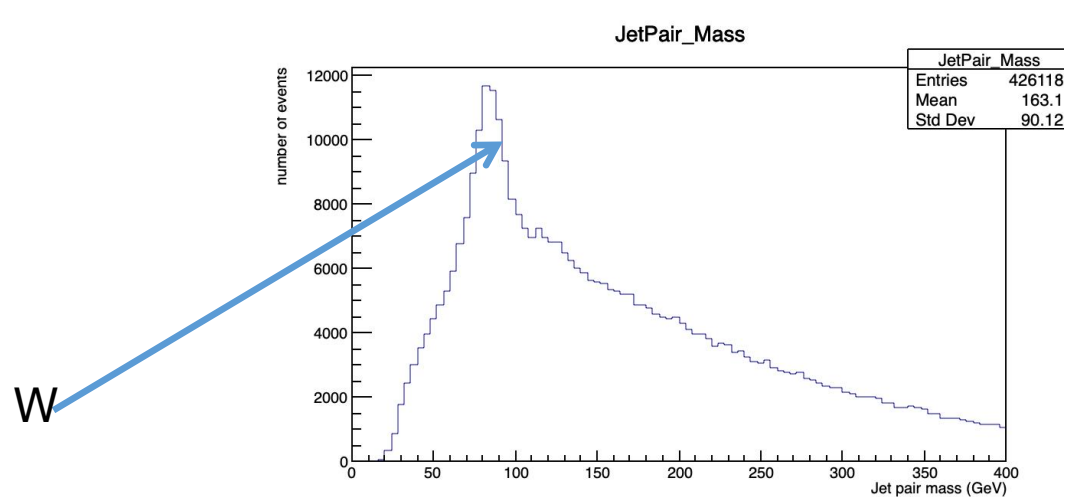


B tag study

➤ After cut 2:

- Basic cuts(loose b tag) && $\Delta R(\mu^+, \mu^-) < 1$ && $\Delta R(\mu^+, \text{loose b jet}) > 1.5$ && $\Delta R(\mu^+, \text{loose b jet}) > 1.5$ && $HT > 300$ && $\mu \text{ pair pt} > 140$ && $70 < \text{non-b(loose) jet pair mass} < 100$

	Number of TT events (after scaling)	Number of Signal events (after scaling)	Ratio S/B_tt
Cut 2	206.2	1.84	0.893%

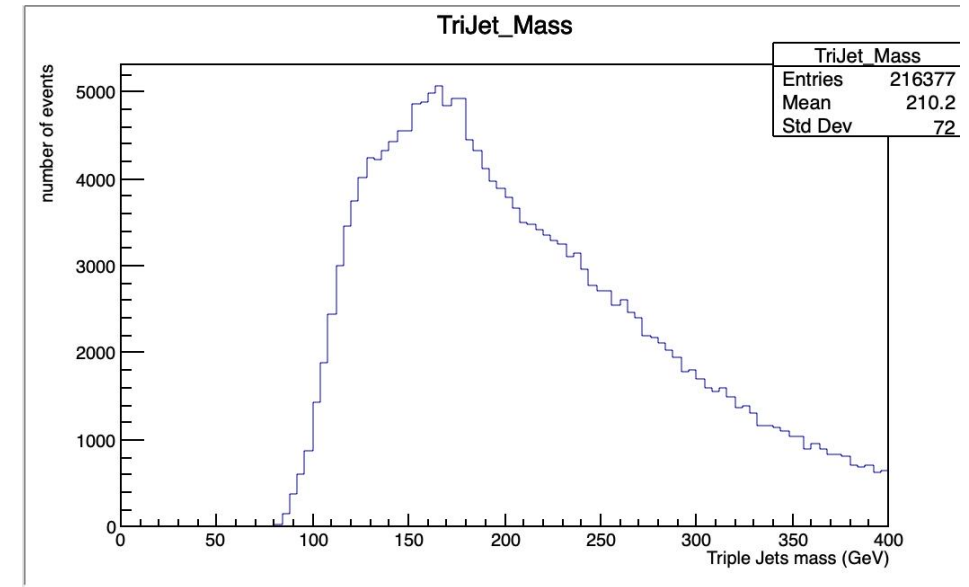
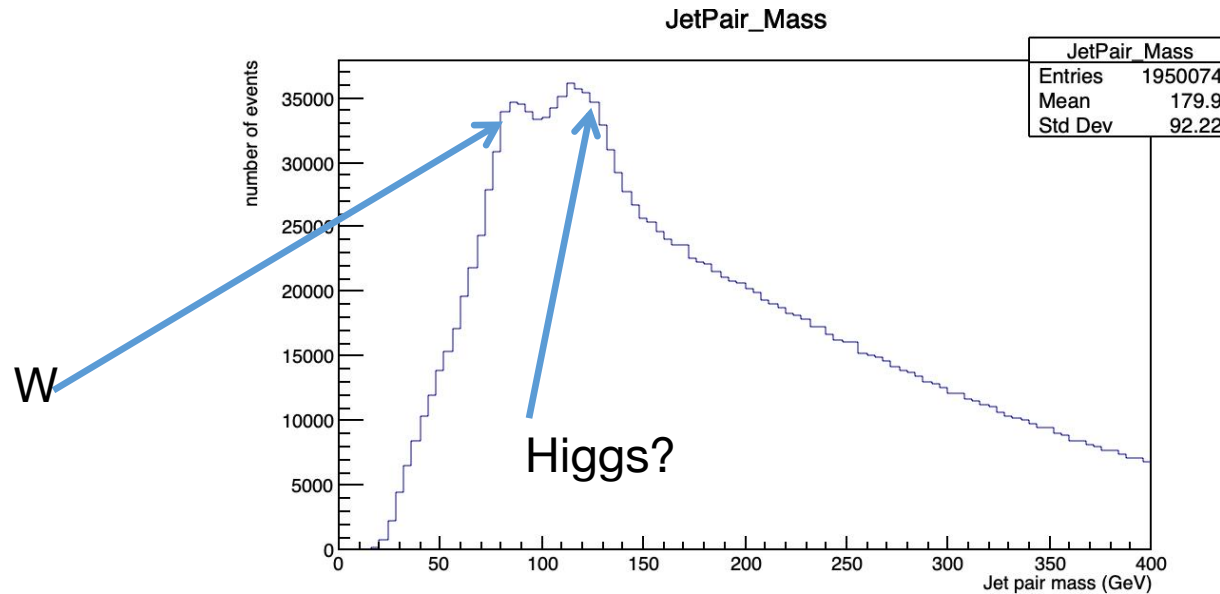


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➤ After cut 3:

- Basic cuts (medium b tag) $\&\& \Delta R(\mu^+, \mu^-) < 1$ $\&\& \Delta R(\mu^+, \text{medium b jet}) > 1.5$ $\&\& \Delta R(\mu^+, \text{medium b jet}) > 1.5$ $HT > 300$ $\&\& \mu \text{ pair pt} > 140$ $\&\& 70 < \text{jet pair mass} < 100$

	Number of TT events (after scaling)	Number of Signal events (after scaling)	Ratio S/B_tt
Cut 3	490.56	3.790	0.773%

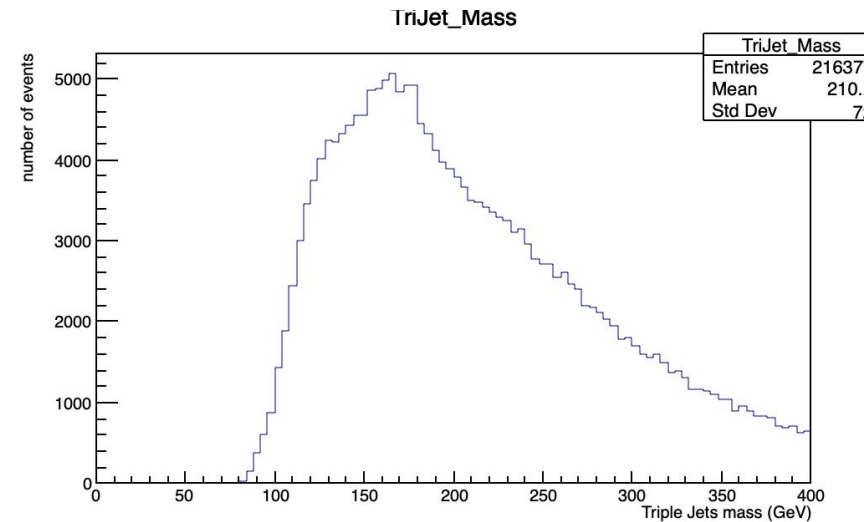
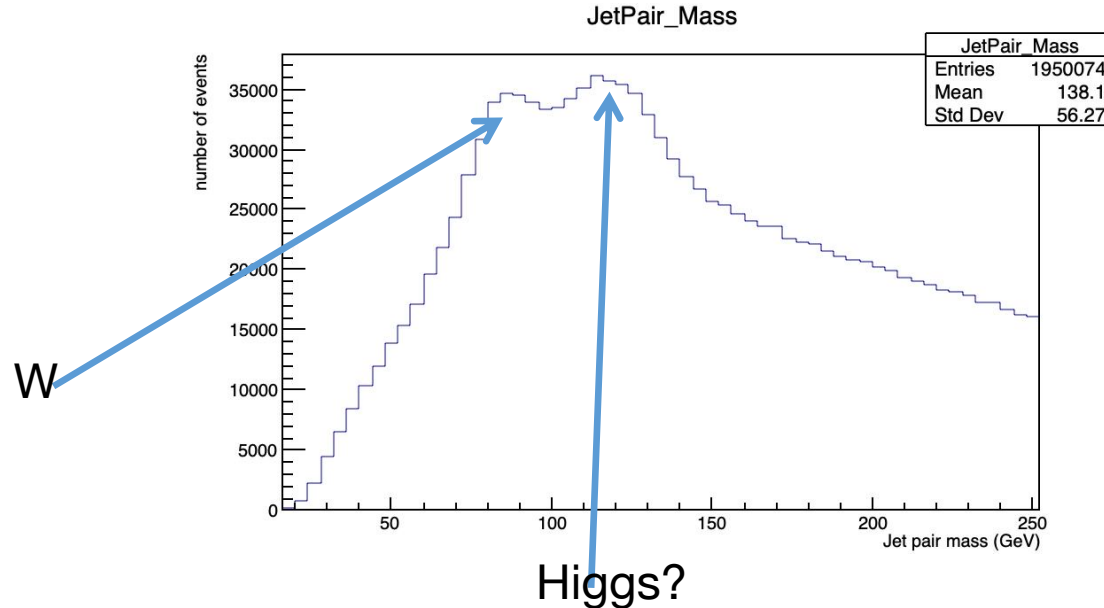


B tag study

➤ After cut 4:

- Basic cuts(loose b tag) $\&\& \Delta R(\mu^+, \mu^-) < 1$ $\&\& \Delta R(\mu^+, \mu^-) < 1$ $\&\& \Delta R(\mu^+, \text{loose b jet}) > 1.5$ $\&\& HT > 300$ $\&\& \mu$ pair pt > 140 $\&\& 70 < \text{jet pair mass} < 100$
- W peak is not very clear, we also have Higgs(?)

	Number of TT events (after scaling)	Number of Signal events (after scaling)	Ratio S/B_tt
Cut 4	680	4.13	0.6075%



Z Mass Window Cut

➤ **Add Z mass window cut to reject case3 events:**

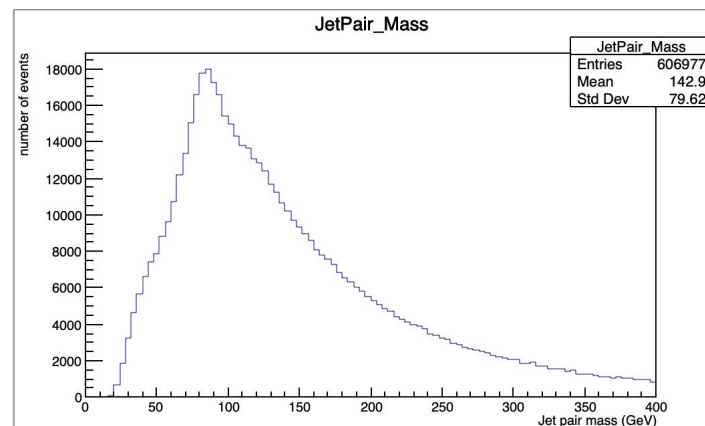
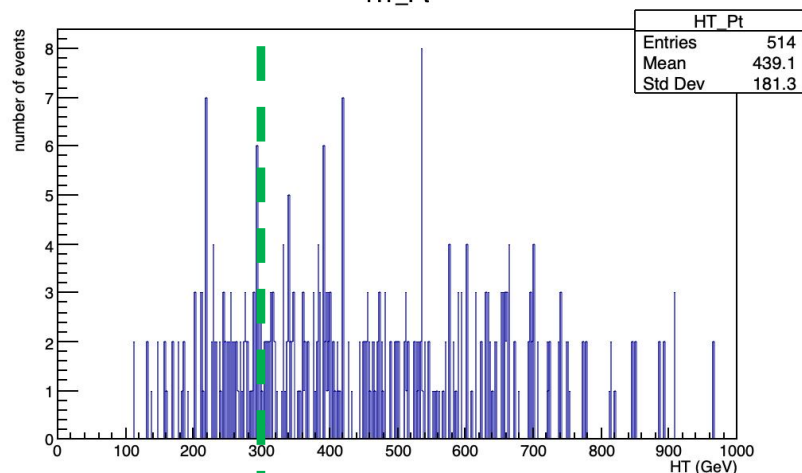
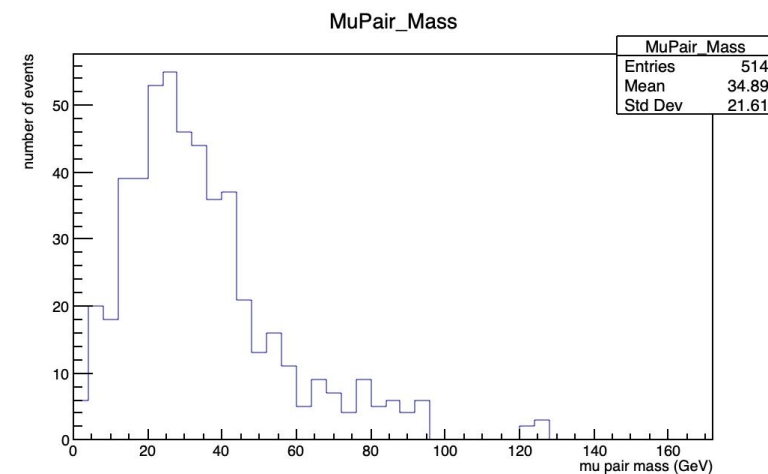
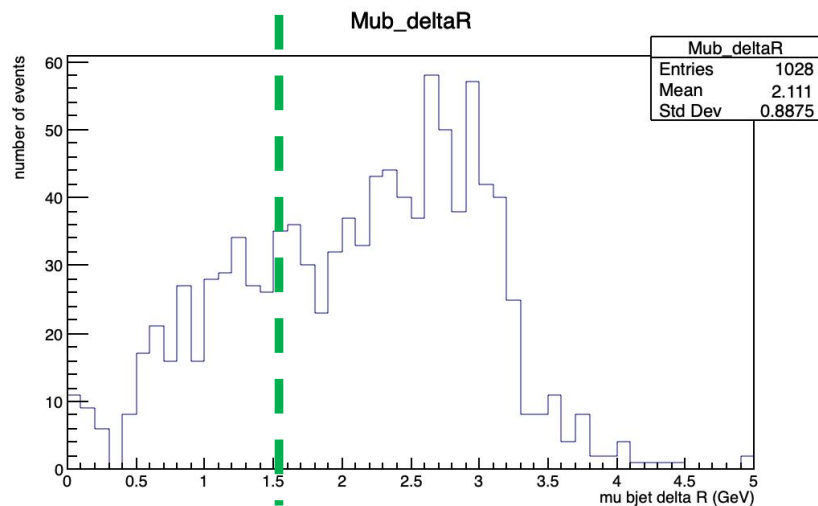
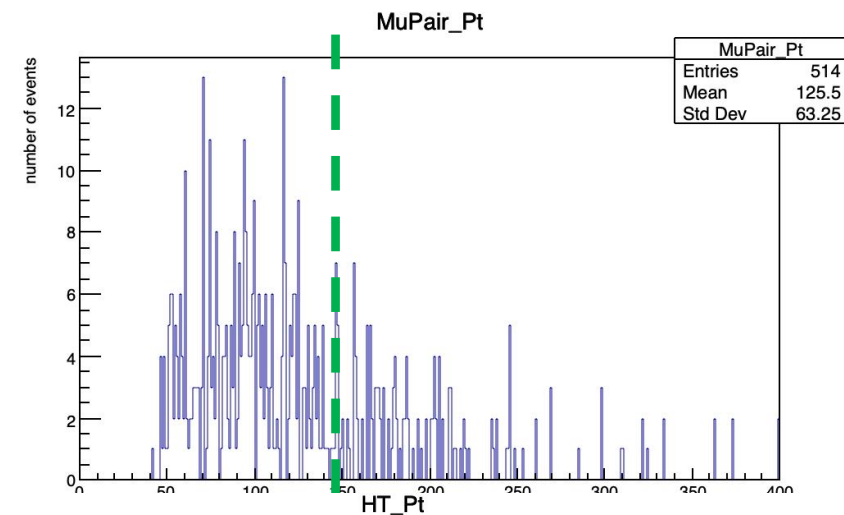
- Basic cuts (medium b tag) && $\Delta R(\mu^+, \mu^-) < 1$ && $\Delta R(\mu^+, \text{medium b jet}) > 1.5$ && $\Delta R(\mu^+, \text{medium b jet}) > 1.5$ && $HT > 300$ && $\mu \text{ pair pt} > 140$ && $70 < \text{non-b (medium) jet pair mass} < 100$ && $\mu \text{ pair mass} \notin [80, 100]$
- **After the Z mass window cut, TZ, WZ are basically gone**

	Number of TT events (after scaling)	Number of TTZ events (after scaling 770fb ⁻¹)	Number of TTW events (after scaling 610.5fb ⁻¹)	Number of WZ events (after scaling 4429.7fb ⁻¹)	Number of Signal events (after scaling 89fb ⁻¹)	Number of TTH events (after scaling 271fb ⁻¹)	Ratio S/B_all
Basic cuts	16701.2	490.36	106.43	10.9	11.68	86.13	0.067%
Cut 1 && $\mu \text{ pair mass} \notin [80, 90]$	189.53	16.67	2.72	0.33(just ignore it)	2.08	10.44	0.937%

TTH Background

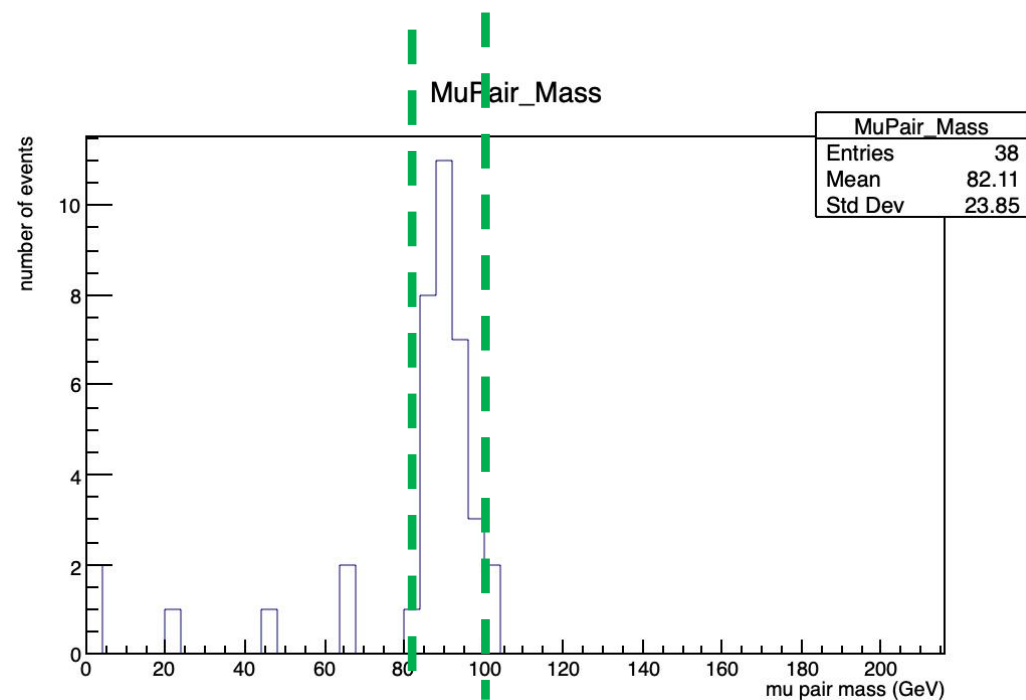
➤ Let's see which cut removed them

- These plots are after basic cut $\Delta R(\mu^+, \mu^-) < 1$
- TTH is sensitive to Muon pair $p_T > 150$, $HT > 300$ and $\Delta R(\mu, b \text{ jet}) > 1.5$



WZ Background

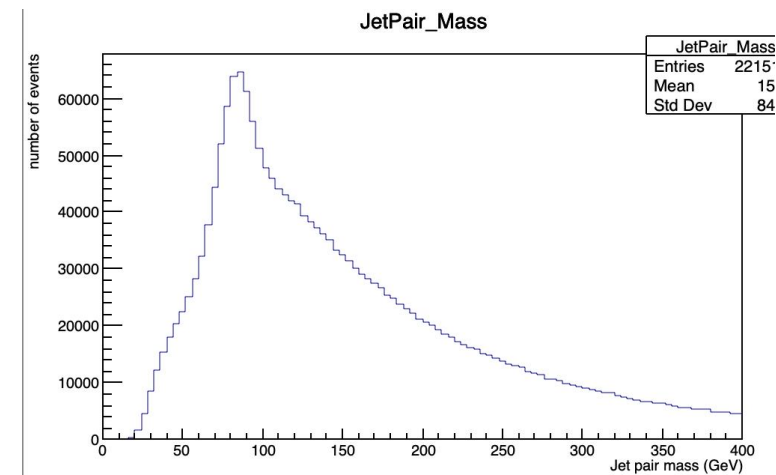
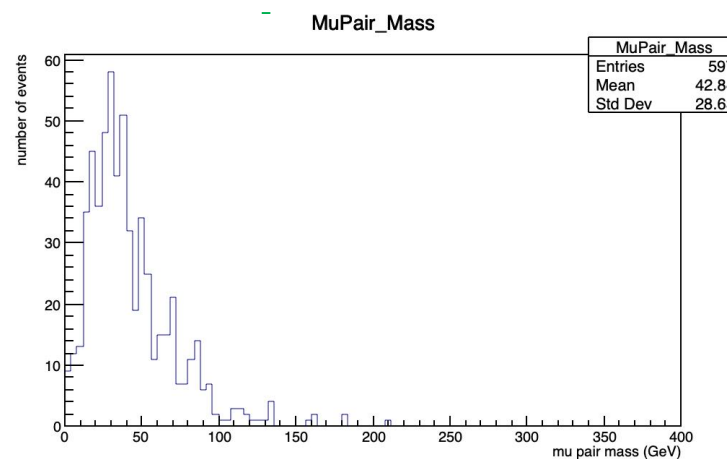
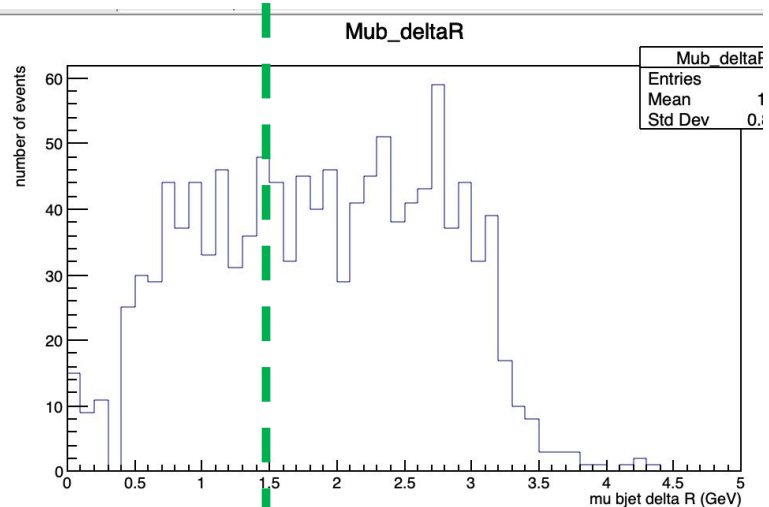
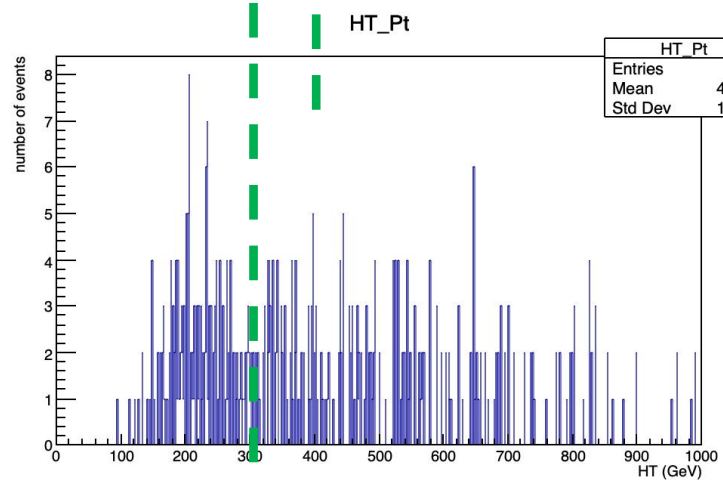
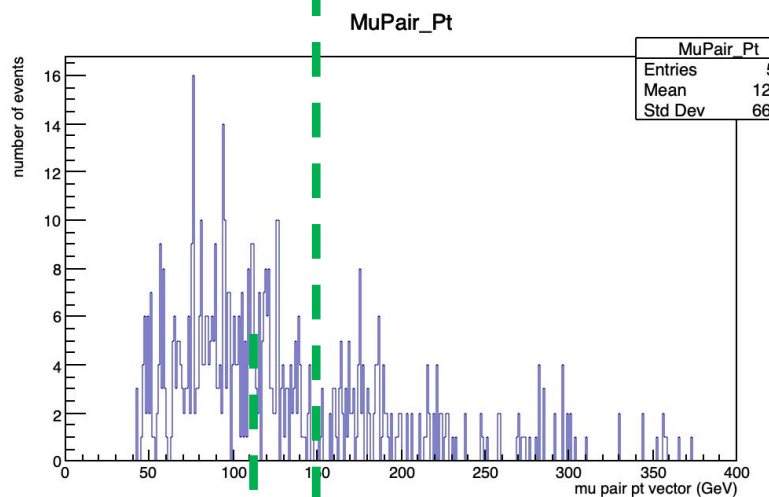
- Let's see which cut removed them
 - These plots are after basic cut $\Delta R(\mu^+, \mu^-) < 1$
 - WZ is sensitive to $n_{\text{bjet}} > 2$ (in basic cuts) and Z mass window cut



TTW Background

➤ Let's see which cut removed them

- These plots are after basic cut $\Delta R(\mu^+, \mu^-) < 1$
- TTW is sensitive to $HT > 300$, $\Delta R(\mu, b \text{ jet}) > 1.5$



TTZ Background

- Let's see which cut removed them
 - These plots are after basic cut $\Delta R(\mu^+, \mu^-) < 1$
 - TTZ is sensitive to Z mass window cut

