Cut Strategy

- We have 3 cases for signal
  - T'->tH; t->Wb->qqb; H->WW->l+l-***vv*** (1 lepton pair, 3 jets and at least 1 b jet)
  - T' -> tH; t->Wb->blv; H->WW->qql (1 lepton pair, 3 jets and at least 1 b jet)
  - T' -> tH; t->Wb->qqb; H->ZZ->l+l-qq (1 lepton pair, 3 jets and at least 1 b jet)

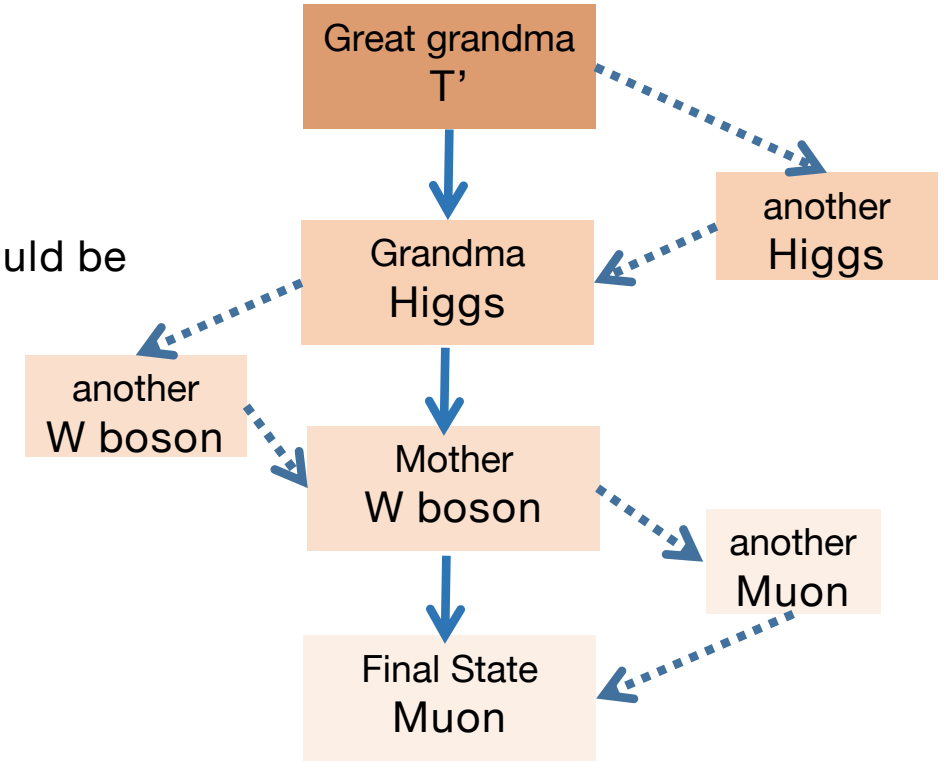
- The following cuts are defined as basic cuts:
  - All muons should pass muon tight ID cut: Muon_tightId
  - All jets should pass tight jet ID cut: Jet_jetId: 6 (tight Jet ID and tightLepVeto ID)
  - ~~Require at least 3 jets in 1 event~~ (This cut is removed this week, I think it's unnecessary)
  - Require at least 1 loose b jet in 1 event. For this b jet, it must be loose b-tag jet: goodJets_btagDeepFlavB>0.049
  - For each muon pair candidate in the event, total charge of muon pair should be 0
  - Pt for each muon should be bigger than 20GeV
  - Pt of each jet is bigger than 30GeV
  - |eta| for each muon should be smaller than 2.4
  - |eta| for each jet should be smaller than 2.5
  - Each muon should pass muon isolation tight cut:
    - goodMuons_miniPFRelIso_all<0.05

- /WWTo2L2Nu_TuneCP5_13TeV-powheg-pythia8/RunIISummer20UL18NanoAODv9-106X_upgrade2018_realisti
- c_v16_L1v1-v2/NANOAODSIM
- /WZTo3LNu_TuneCP5_13TeV-amcatnloFXFX-pythia8/RunIISummer20UL18NanoAODv9-106X_upgrade2018_reali
- stic_v16_L1v1-v2/NANOAODSIM

GEN Information Study (Signal MC)

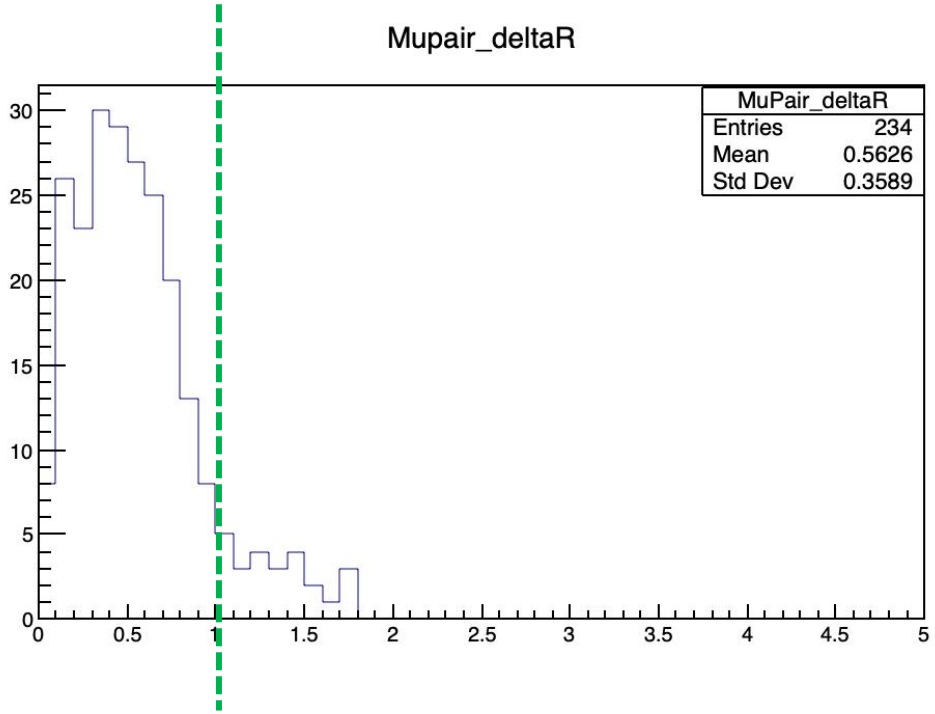
- Let's focus on 1 signal process first!
  - T'->tH; t->Wb->qqb; H->WW->l+l-***νν*** (1 lepton pair OS, 1 b jet)

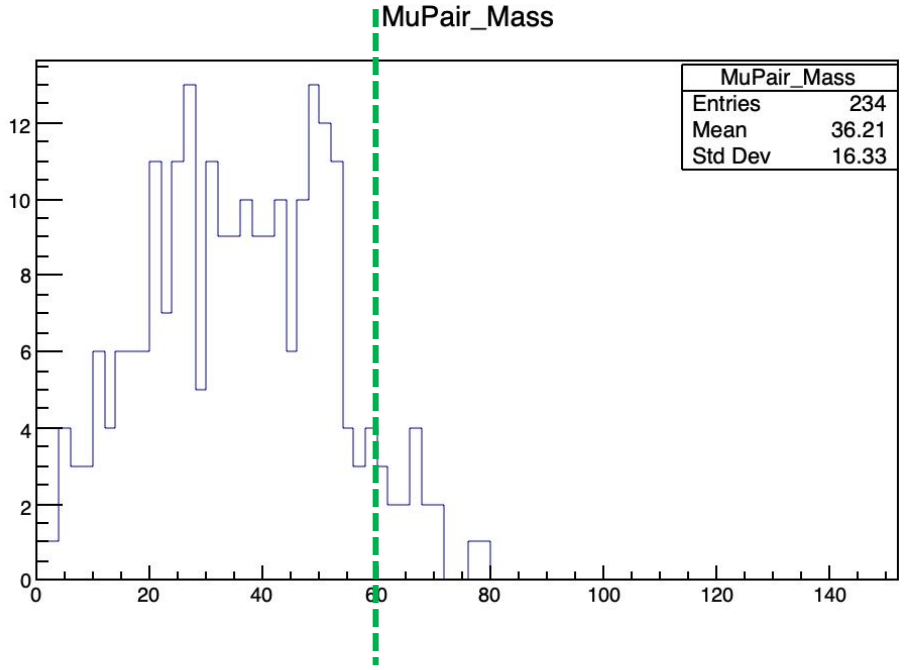
- Full decay chain GEN matching is applied
  - Use signal 18 MC sample
  - Get GEN information for full decay chain
  - Consider multi muons/ W bosons/ Higgs: Mother of Mu/ W/ H could be another Mu/ W/ H
  - Basic cuts for muons and jets are applied
  - Find 8 events after scaling (signal cross section is 89fb-1)
  - Several cuts could be selected to get the real signal
    - delta R
    - Mu pair mass



GEN Information Study (Signal MC)

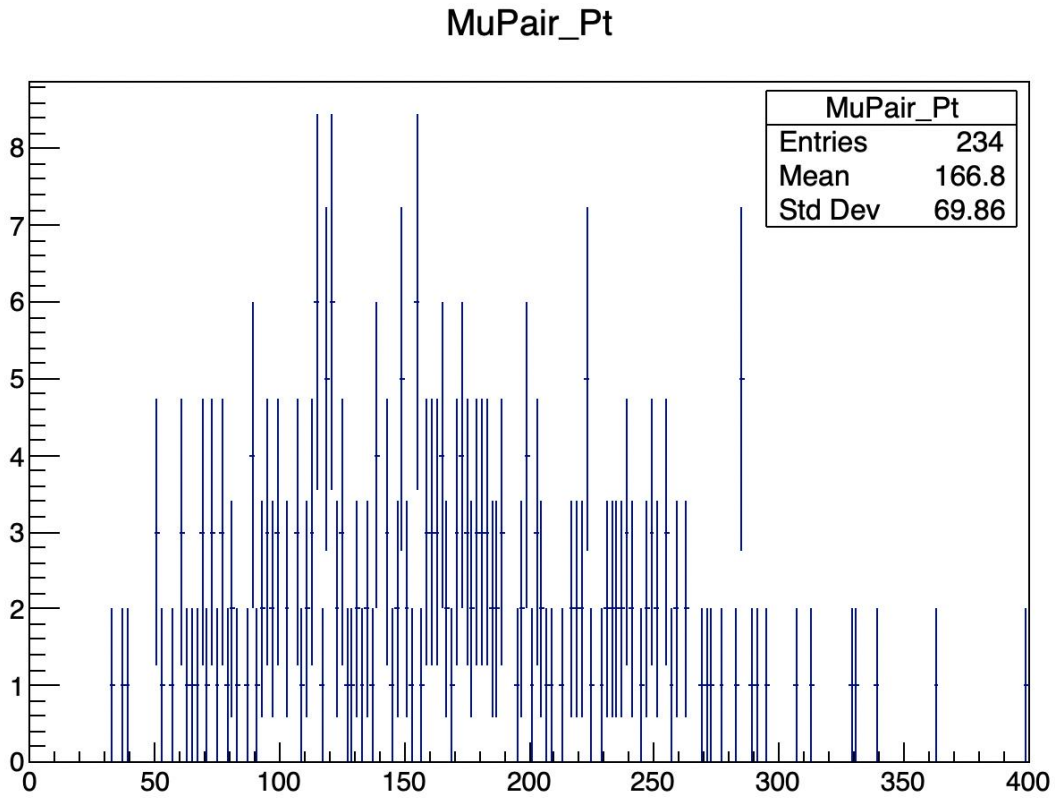
- These 2 cuts could be applied
  - deltaR (mu+, mu-) < 1
  - Mass (mu pair) < 60 GeV

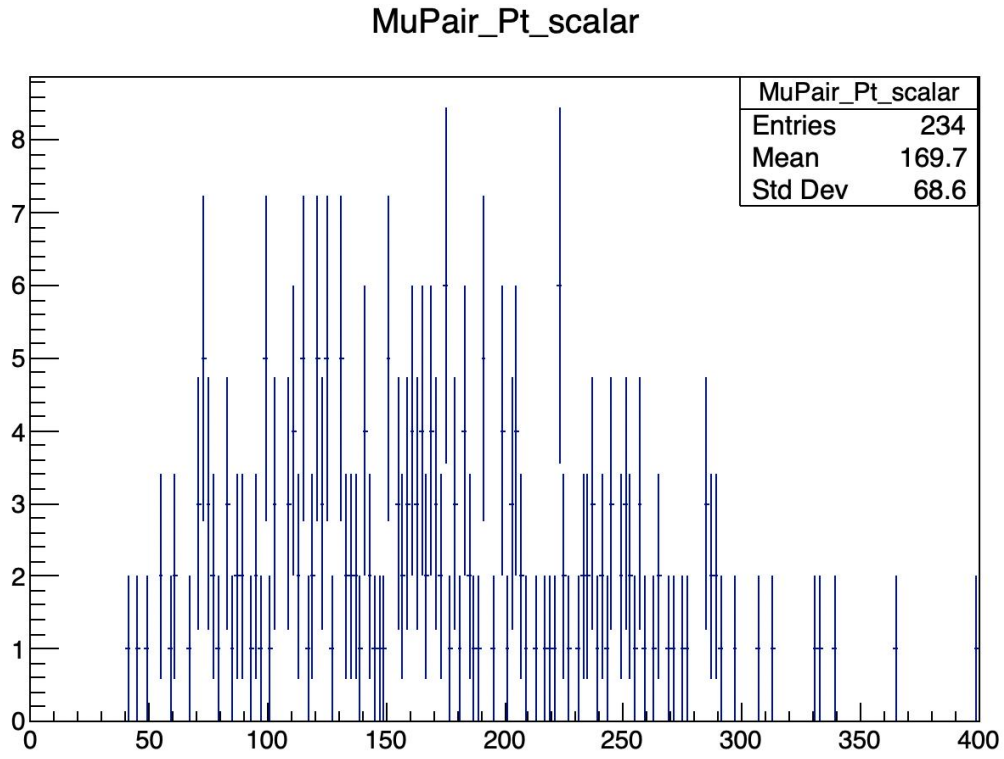




GEN Information Study (Signal MC)

- Check the distribution of mu pair pT
  - Cuts need to be optimized

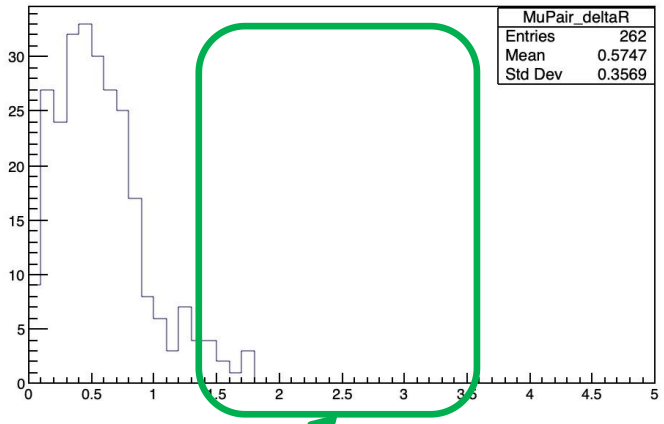




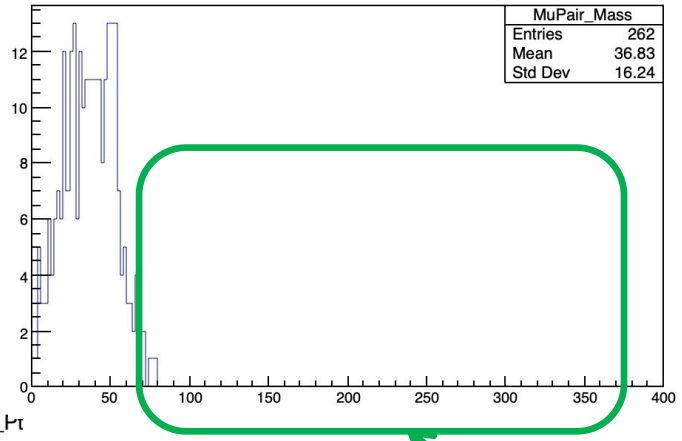
GEN Information Study (Signal MC)

- Half decay chain GEN matching for cross check
  - Use signal 18 MC sample
  - Basic cuts for muons and jets are applied
  - Perform GEN matching for H->W-> Mu
  - Consider multi muons: Mother of Mu could be another Mu
  - Find 8.95 events after scaling (signal cross section is 89fb)

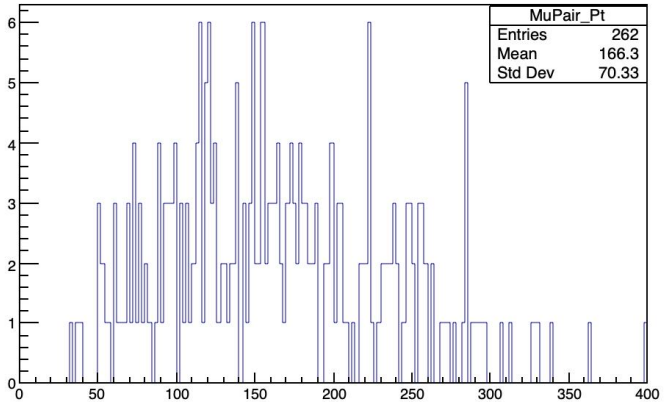
Mupair_deltaR



MuPair_Mass

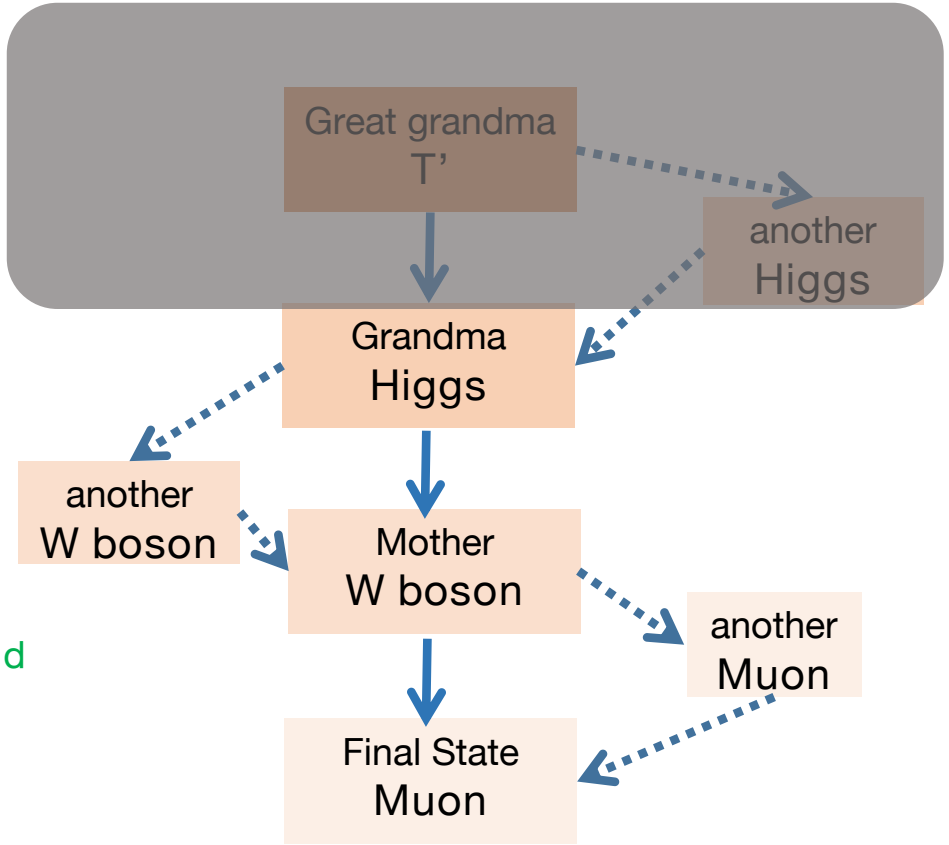


MuPair_Pt



Most Background are removed

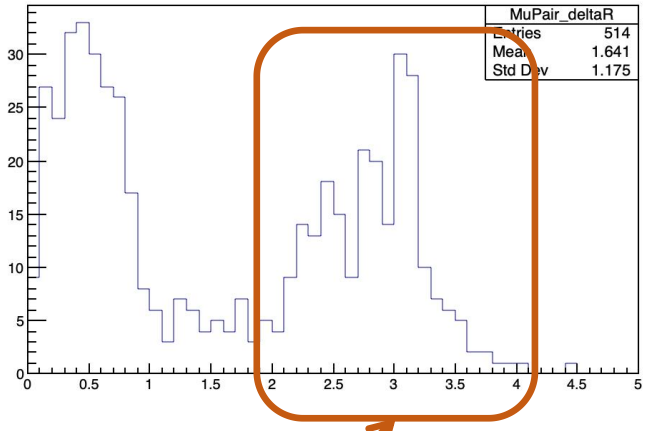
Most Background are removed



GEN Information Study (Signal MC)

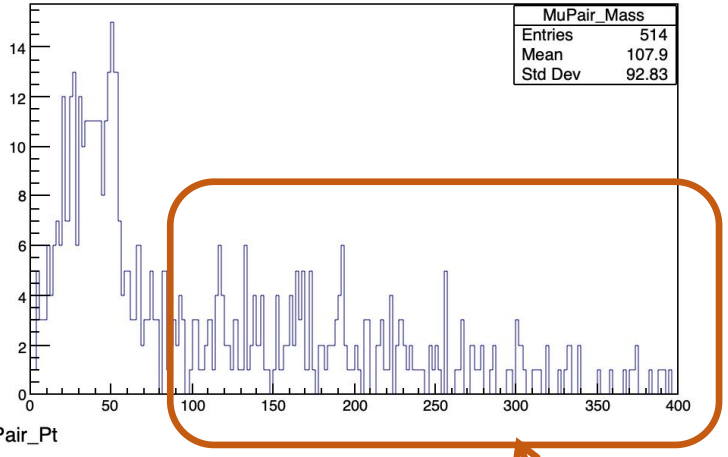
- Half decay chain GEN matching for cross check
  - Use signal 18 MC sample
  - Basic cuts for muons and jets are applied
  - Perform GEN matching for W-> Mu
  - Consider multi muons: Mother of Mu could be another Mu
  - Find 17 events after scaling (signal cross section is 89fb)

Mupair_deltaR



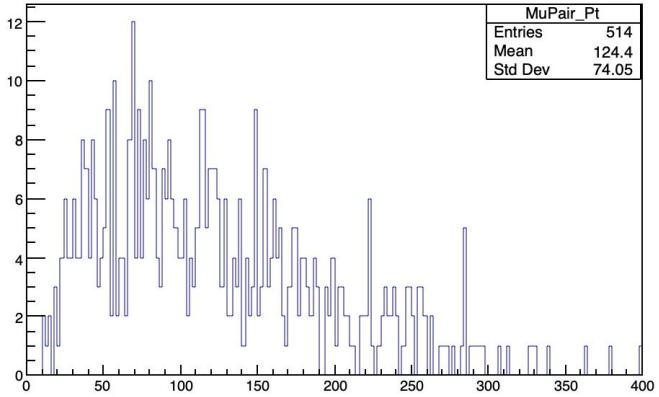
Background

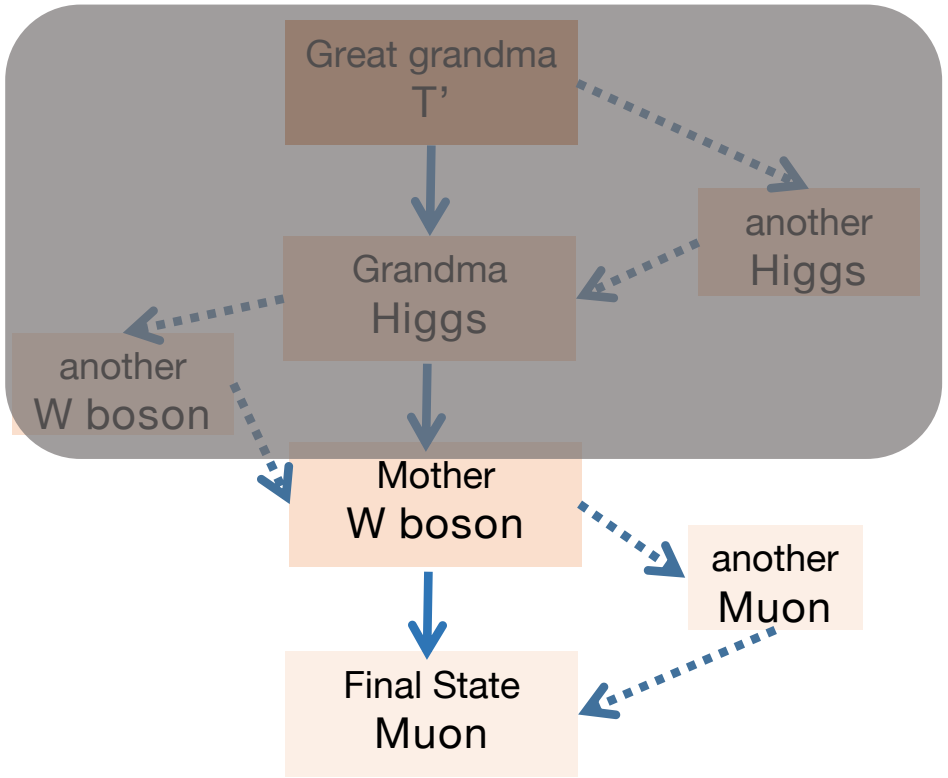
MuPair_Mass



Background

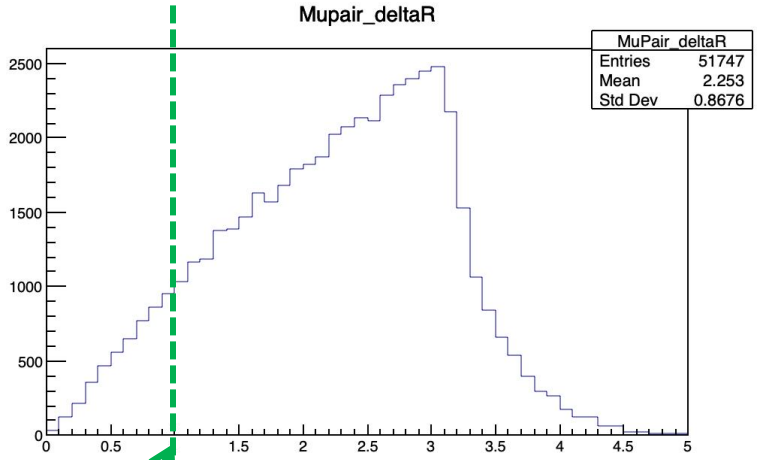
MuPair_Pt



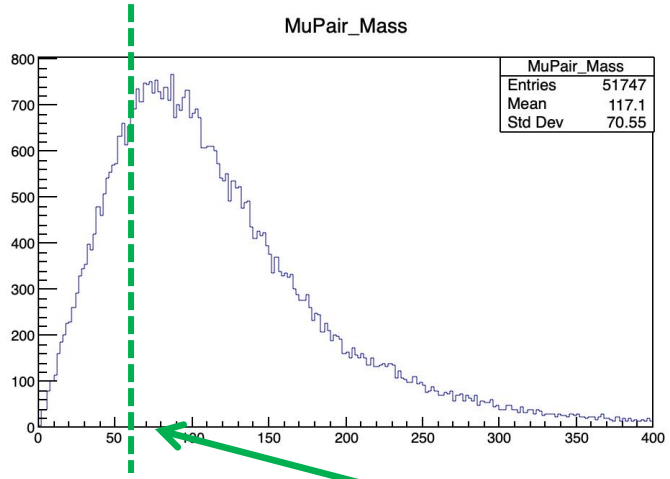


GEN Information Study (TT MC)

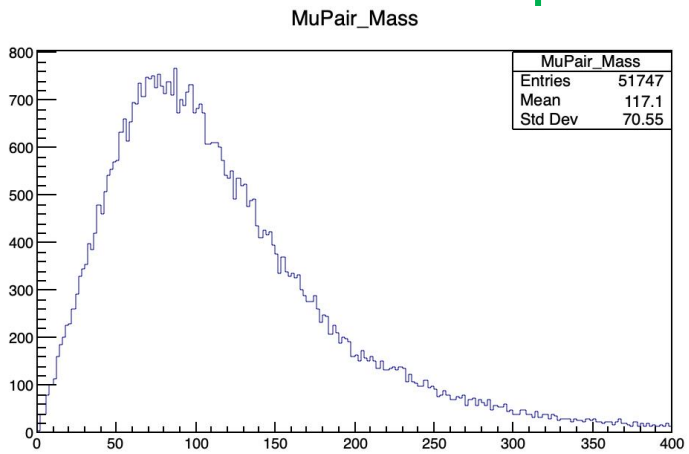
- Half decay chain GEN matching for cross check
  - Use TT 18 MC sample (only checked a few files)
  - Basic cuts for muons and jets are applied
  - Perform GEN matching for W-> Mu (No events wil left if add further GEN matching)
  - Consider multi muons: Mother of Mu could be another Mu
  - Find 288461.2 events after scaling (TT cross section is 88.3pb)

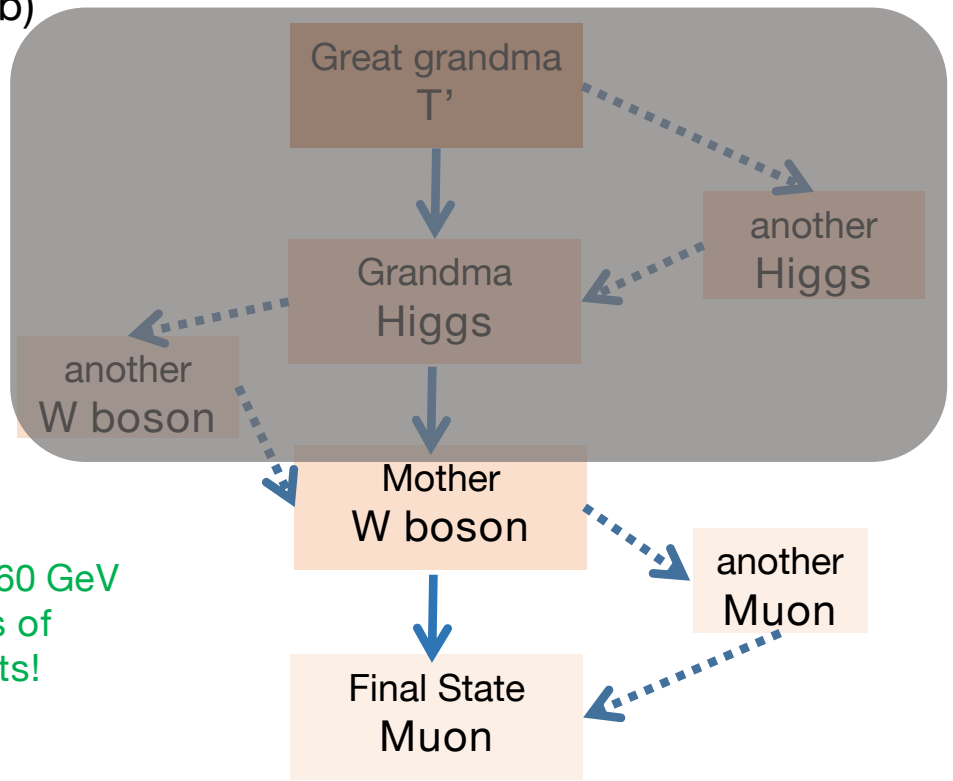


deltaR (mu+, mu-) < 1 could remove lots of background events!



Mass (mu pair) < 60 GeV could remove lots of background events!

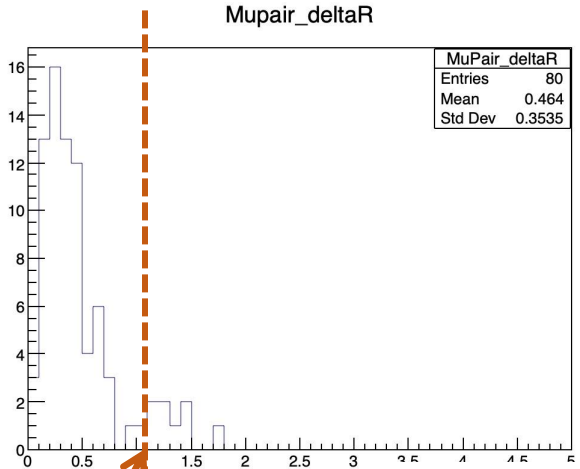




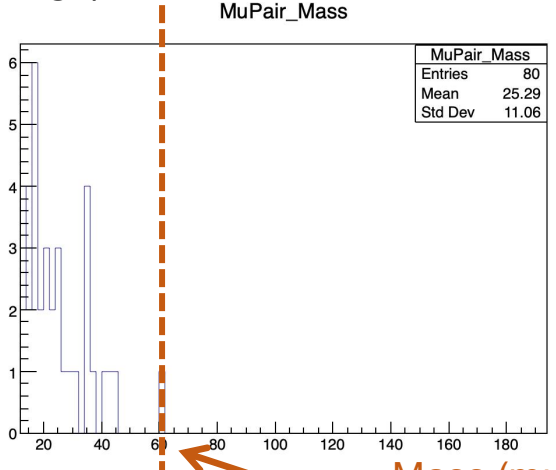
Obviously different from signal!

GEN Information Study (WZ MC)

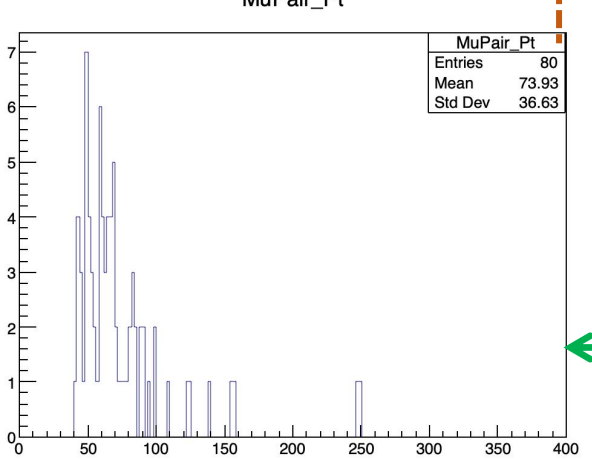
- Half decay chain GEN matching for cross check
  - Use WZ 18 MC sample (only checked a few files)
  - Basic cuts for muons and jets are applied
  - Perform GEN matching for W-> Mu (No events wil left if add further GEN matching)
  - Consider multi muons: Mother of Mu could be another Mu
  - Find 199 events after scaling (WZ cross section is 27.6pb)



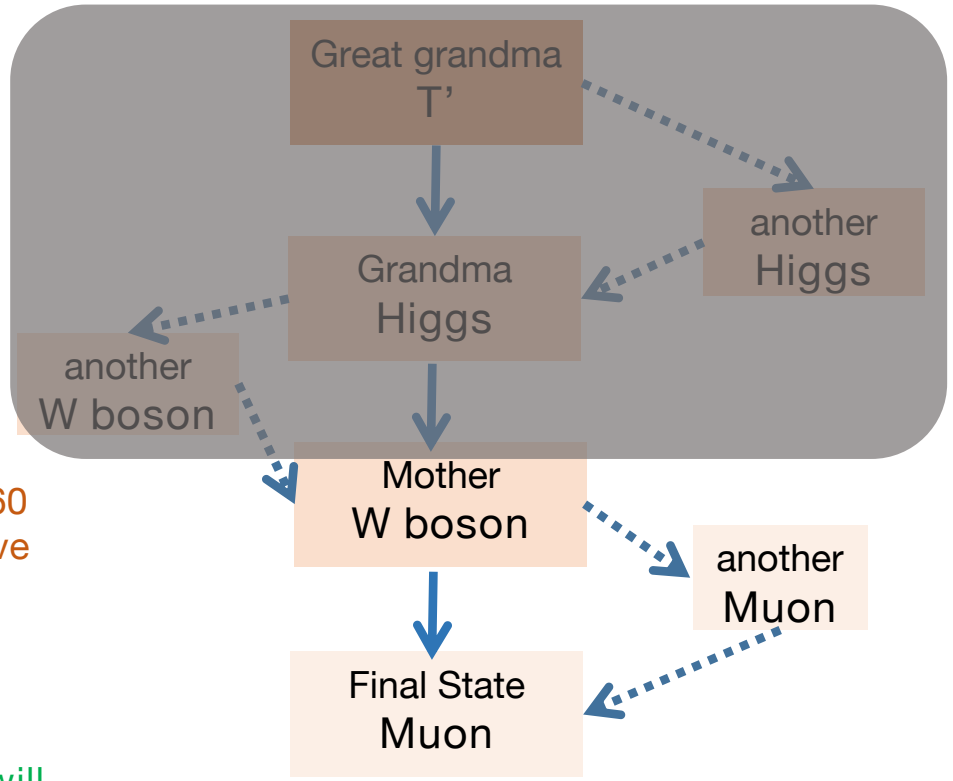
deltaR (mu+, mu-) < 1 cannot remove WZ background events!



Mass (mu pair) < 60 GeV cannot remove WZ background events!

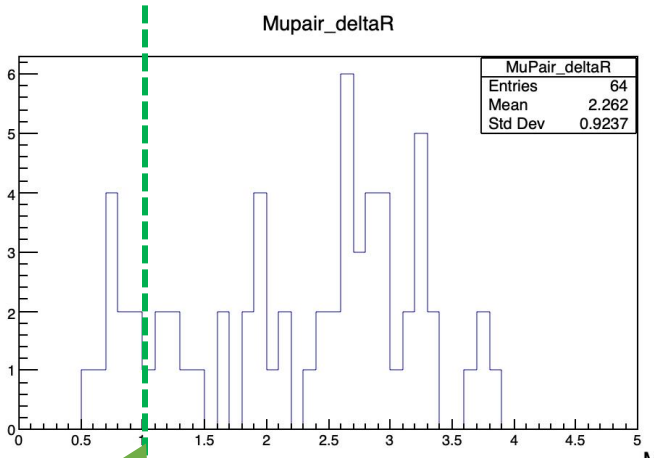


Cut on mu pair pt will remove most WZ background events!

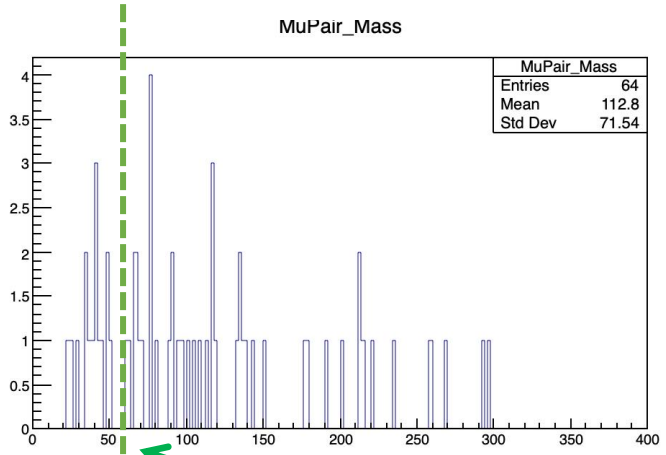


GEN Information Study (WW MC)

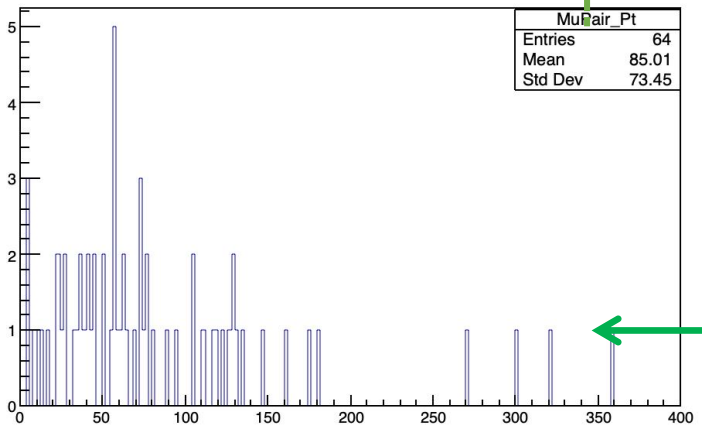
- Half decay chain GEN matching for cross check
  - Use WW 18 MC sample (only checked a few files)
  - Basic cuts for muons and jets are applied
  - Perform GEN matching for W-> Mu (No events wil left if add further GEN matching)
  - Consider multi muons: Mother of Mu could be another Mu
  - Find 17077 events after scaling (WW cross section is 75.9pb)



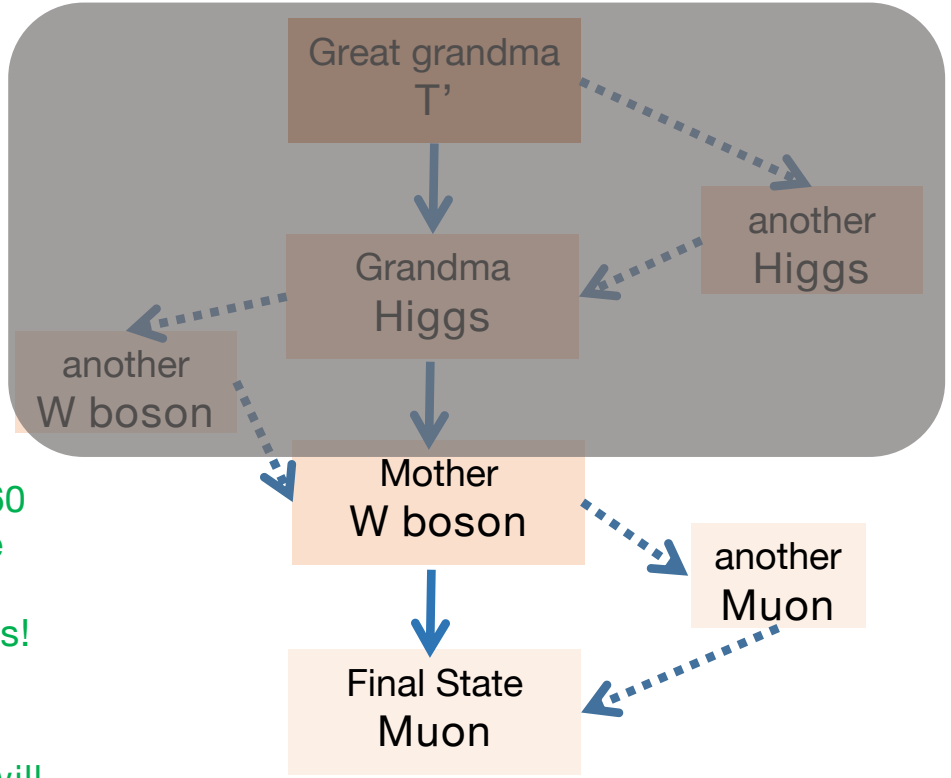
deltaR (mu+, mu-) < 1 could remove some WW background events



Mass (mu pair) < 60 GeV could remove come WW background events!



Cut on mu pair pt will remove many WW background events!



MC Study with New Cuts

- Remove GEN matching and apply the following cuts to signal MC and tt bar MC
  - Basic cuts
  - deltaR (mu+, mu-) < 1
  - Mass (mu pair) < 60 GeV
- Many TT background events are removed after 2 new cuts
  - We still have lots of TT background (It's natural to observe them in OS channel)

	Number of TT events (after scaling)	Number of WW events (after scaling)	Number of WZ events (after scaling)	Number of Signal events (after scaling)
Basic cuts	335740.6	20493	26728.6	36.8 (lots of fake signal)
deltaR (mu+, mu-) < 1	31707.7	3415.5	3865.4	16.5
Mass (mu pair) < 60 GeV	29907	2277	1541.4	13.1