Z(tau tau)H(bb) Investigation
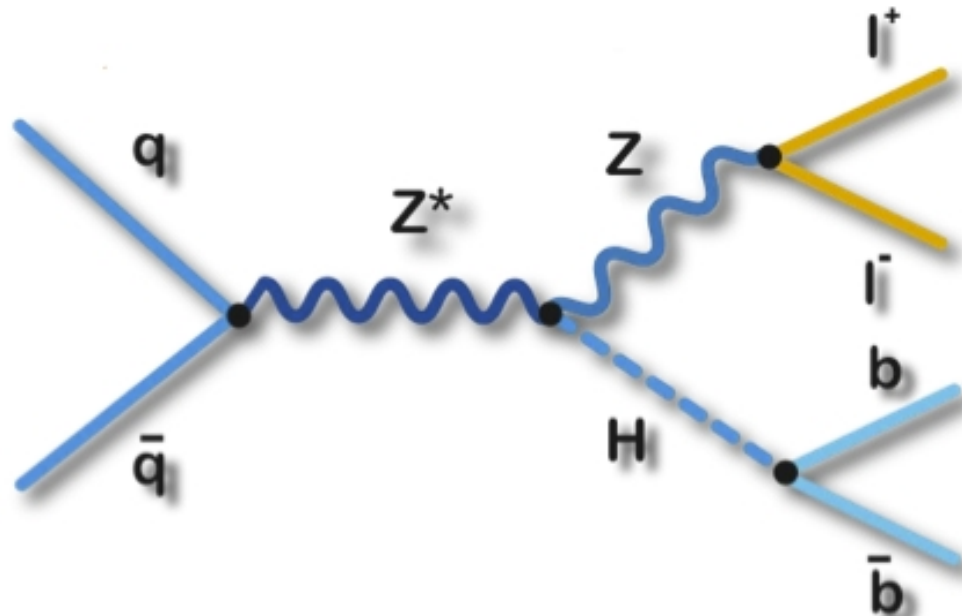## Fully Hadronic Channel

Is it worth the effort?

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Motivation

◆ We don't have a dedicated Z(tau tau)H channel in current VH(bb) analysis.

◆ Goal: see if a channel explicitly selecting hadronic tau decays could bring additional sensitivity for this analysis.

Setup

◆ Unskimmed 2 Lepton qqZH125 & ggZH125 Samples, Full Stats used:

mc15_13TeV.345055.PowhegPythia8EvtGen_NNPDF3_AZNLO_ZH125J_MINLO_llbb_VpT.merge.DAOD_HIGG2D4.e5706_s2726_r7772_r7676_p2952

mc15_13TeV.345057.PowhegPythia8EvtGen_NNPDF3_AZNLO_ggZH125_llbb.merge.DAOD_HIGG2D4.e5706_s2726_r7772_r7676_p2952

- Run the 0-lepton CxAOD Maker with no Selection.

- Run the default 0-lepton Reader.

- For the events that do not pass the default 0-lepton selections, consider dedicated tau tau selections.

Event Selection in 0-lep

◆ 0lep Maker:
   NO Maker Selection: (No: 0loose lep, nJ>=2, and MET>140 GeV)

● 0lep Reader Common Cuts:

1. Pass0lep MET trigger.

2. exactly zero VHLoose leptons

3. MET > 150 GeV.

4. SumPtJet>120 (nJ=2),
            >150 (nJ>=3).

5. dPhi(MET, MPT) < 90 degree.

6. MindPhiMETJet>20(nJ<3),30(nJ>=3).

7. PtB1>45GeV.

8. dPhiBB<=140.

9. dPhiMETdijet >120.

Reader CutFlow

- Cutflow for events that Pass the 0lep common cuts.

qqZH sample
Initial number of events = 370.46
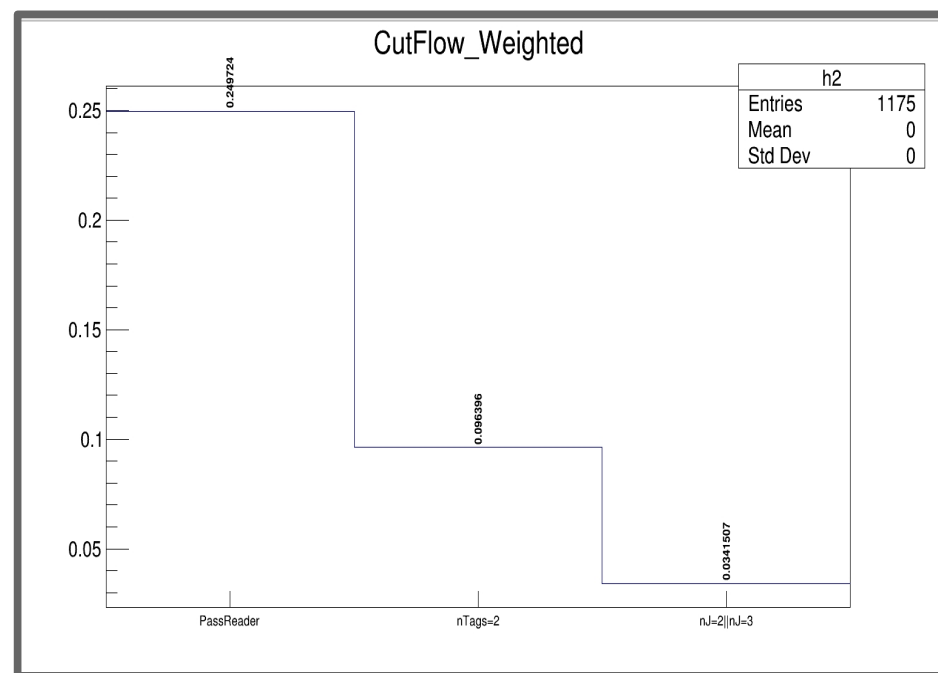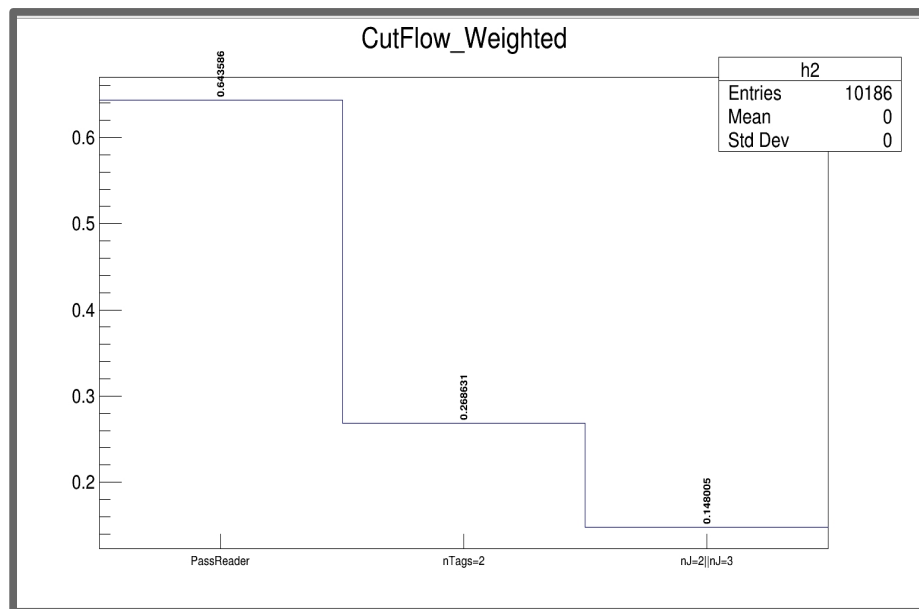
ggZH sample
Initial number of events = 57.24

Tau Tau Selection

◆ For events that Don't Pass the 0lep Reader selection, dedicated tau tau selections:

Object Selection:

1. Pt > 20 GeV.

2. |eta| < 2.5.

3. 1 or 3 tracks.

4. IsBDTMedium.

Event Selection:

1. Pass tau or tau+MET or MET Triggers.

2. nTags=2.

3. nJ>=2.

4. nTaus=2.

5. pTB1>45 GeV.

6. pTZ>150 GeV.

Tau Trigger List

◆ **Triggers data15:**

***Single tau
HLT_tau80_medium1_tracktwo
HLT_tau80_medium1_tracktwo_L1TAU60

***DiTau
HLT_tau35_loose1_tracktwo_tau25_loose1_tracktwo_L1TAU20IM_2TAU12IM
HLT_tau35_medium1_tracktwo_tau25_medium1_tracktwo_L1TAU20IM_2TAU12IM

***Tau+MET
HLT_tau35_medium1_tracktwo_L1TAU20_tau25_medium1_tracktwo_L1TAU12_xe50
HLT_tau35_medium1_tracktwo_L1TAU20_xe70_L1XE45
HLT_tau35_medium1_tracktwo_L1TAU20_tau25_medium1_tracktwo_L1TAU12_xe50w
HLT_tau35_medium1_tracktwo_xe70_L1XE45 (w/ J20)

Tau Trigger List

- **Triggers data16:**

***single tau
HLT_tau80_medium1_tracktwo_L1TAU60
HLT_tau125_medium1_tracktwo
HLT_tau160_medium1_tracktwo

***DiTau
HLT_tau35_loose1_tracktwo_tau25_loose1_tracktwo
HLT_tau80_medium1_TAU60_tau50_medium1_L1TAU12

***Tau+MET
HLT_tau35_medium1_tracktwo_xe70_L1XE45
HLT_tau35_medium1_tracktwo_L1TAU20_tau25_medium1_tracktwo_L1TAU12_xe50
HLT_tau35_medium1_tracktwo_tau25_medium1_tracktwo_xe50
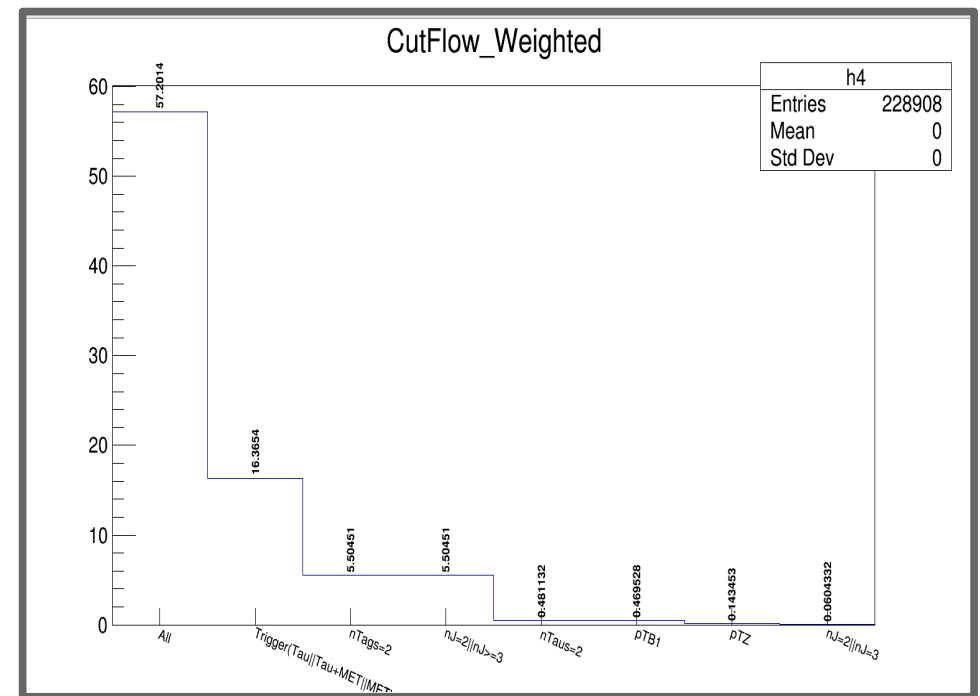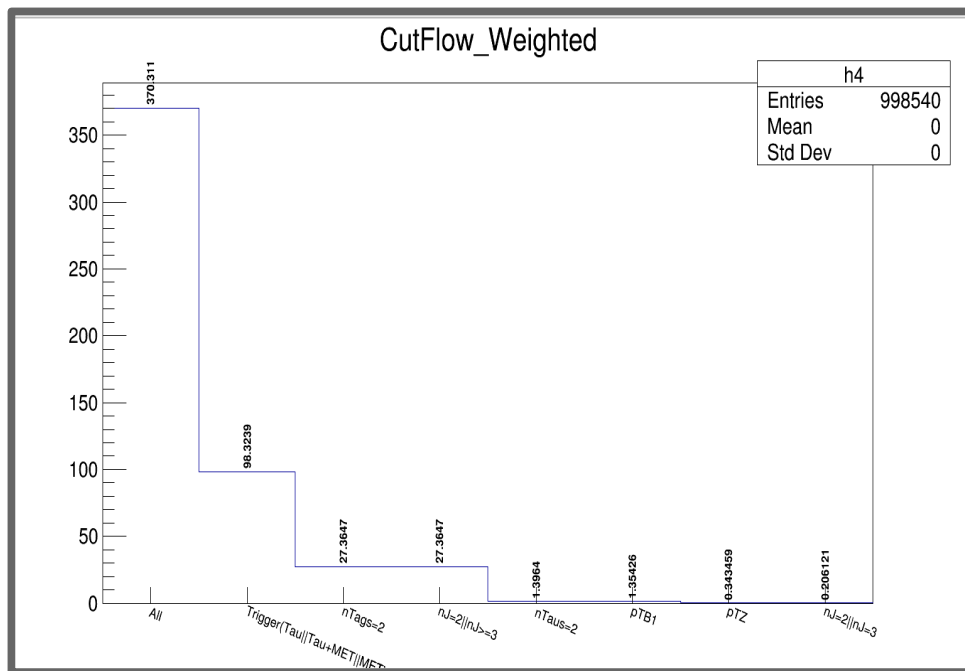
#Events in different Trigger categories

- For events that Don't Pass the 0lep selection, no events pass MET Trigger Only.
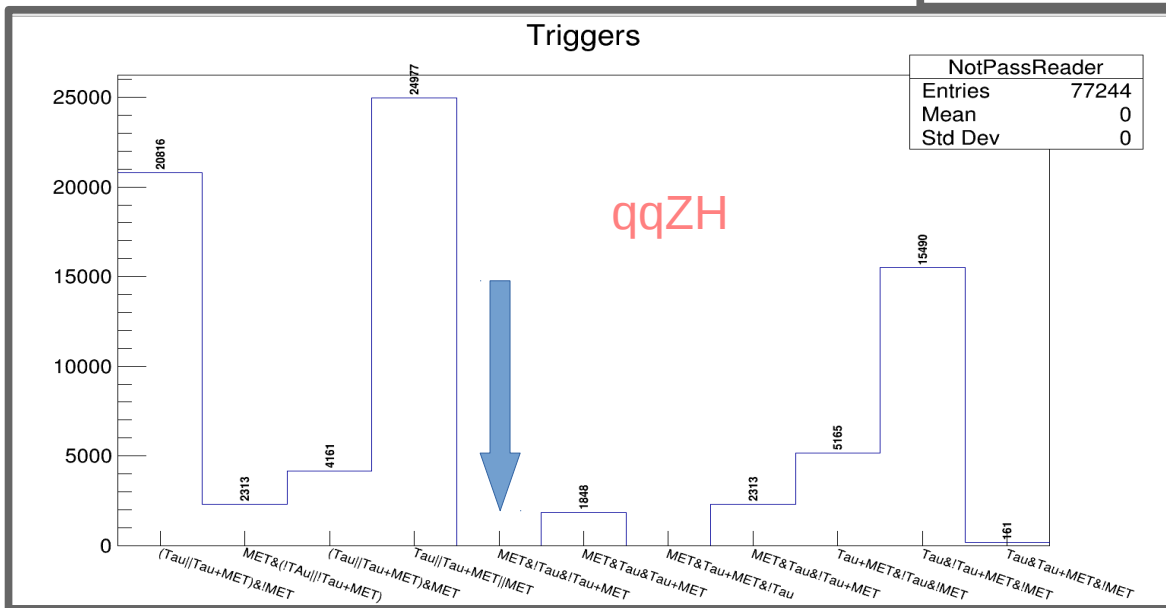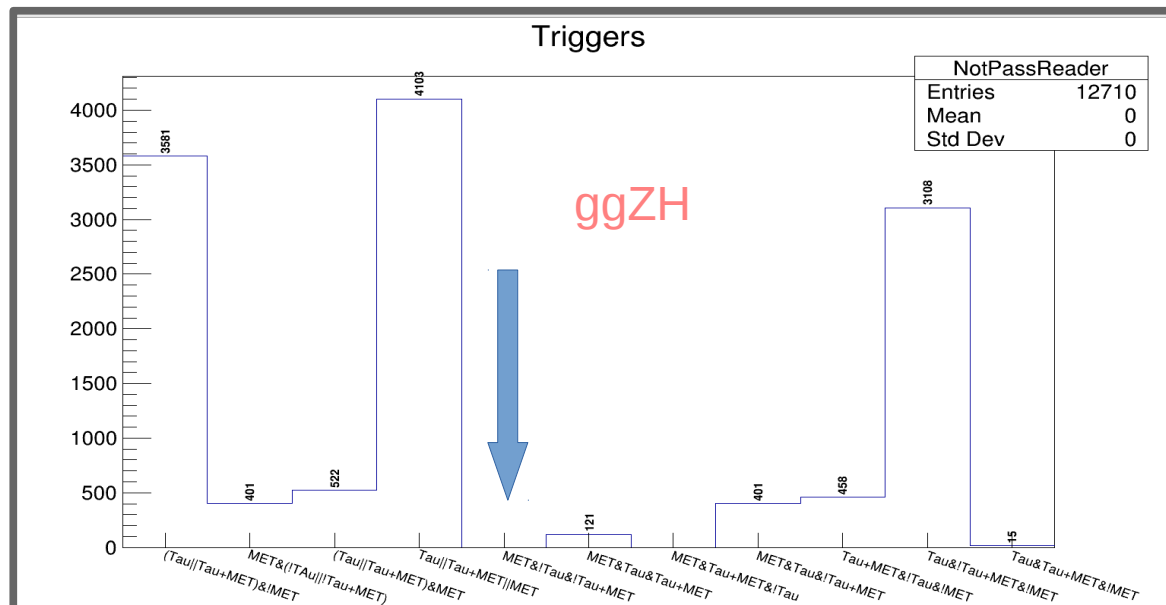
Reader CutFlow

- Cutflow for events that Don't Pass the 0lep selection.
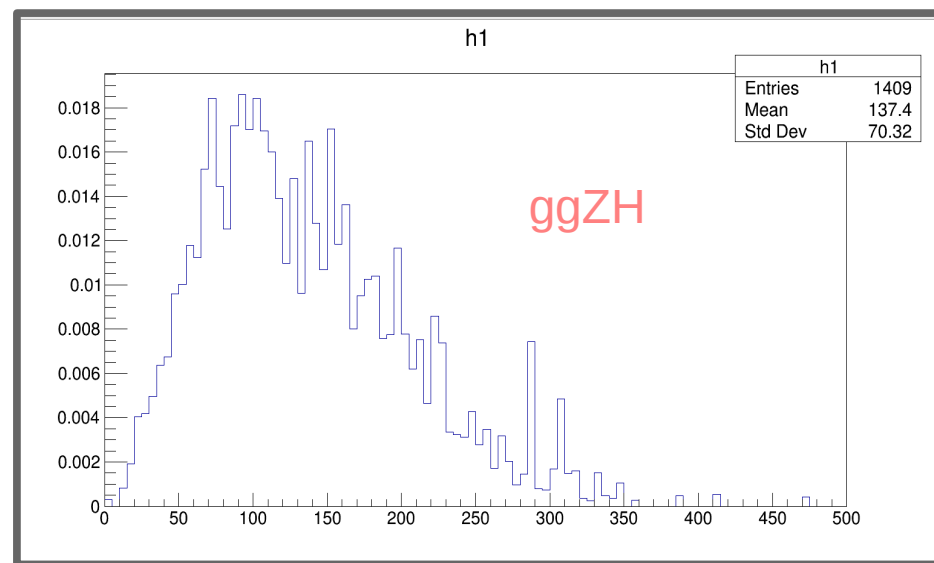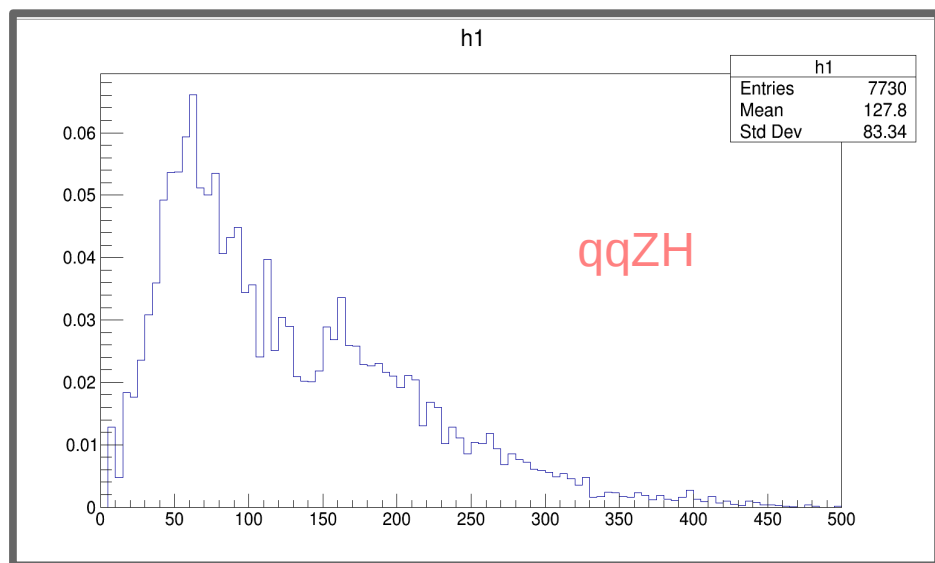

qqZH sample
Initial number of events = 370.46

ggZH sample
Initial number of events = 57.24

- Up to the pTZ>150 GeV, the events yield is 0.49 for both samples

PTZ Distribution

- pTZ distribution before the pTZ>150 GeV cut.

Where pTZ calculated as:

$$(\vec{p_T})_Z = (\vec{p_T})_{Tau1} + (\vec{p_T})_{Tau2} + (\vec{p_T})_{MET}$$

Conclusion

- Total number of di-lepton events is 428.

- Events pass 0lep selection is 0.18.

- With a dedicated tau tau selection, max possible addition is 0.49.

- This preliminary study shows that a dedicated analysis for the Z(tau tau)H fully hadronic channel is probably useless.

- Prospective: Looking for semileptonic tau decay using 1lep selection.

Backup

Reader CutFlow: Summary

Cuts	ggZH Yield	qqZH Yield	Total
Initial	57.24	370.46	427.7
All (doesn't pass 0lep selection)	57.20	370.31	427.54
pass(Tau||Tau+MET)	16.37	98.32	114.69
nTags=2	5.5	27.36	32.86
nTaus	0.48	1.40	1.88
PTB1>45 GeV	0.47	1.35	1.82
PTZ > 150 GeV	0.15	0.34	0.49