Trigger studies for the Higgs pair production in the WWbb final state at √s= 13 TeV with the ATLAS detector

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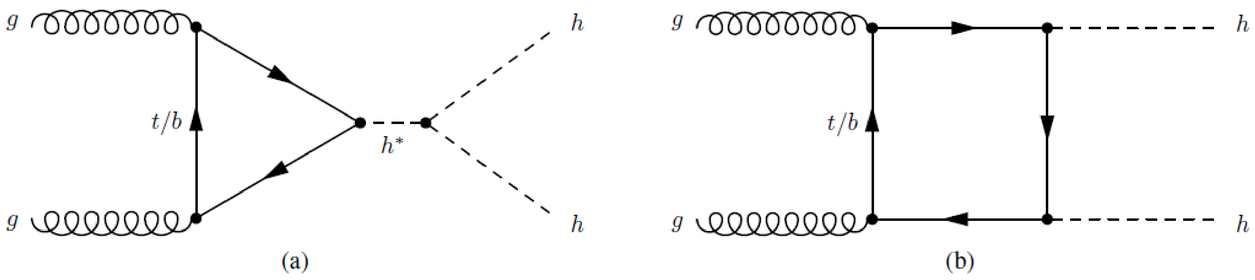
Introduction and Motivations

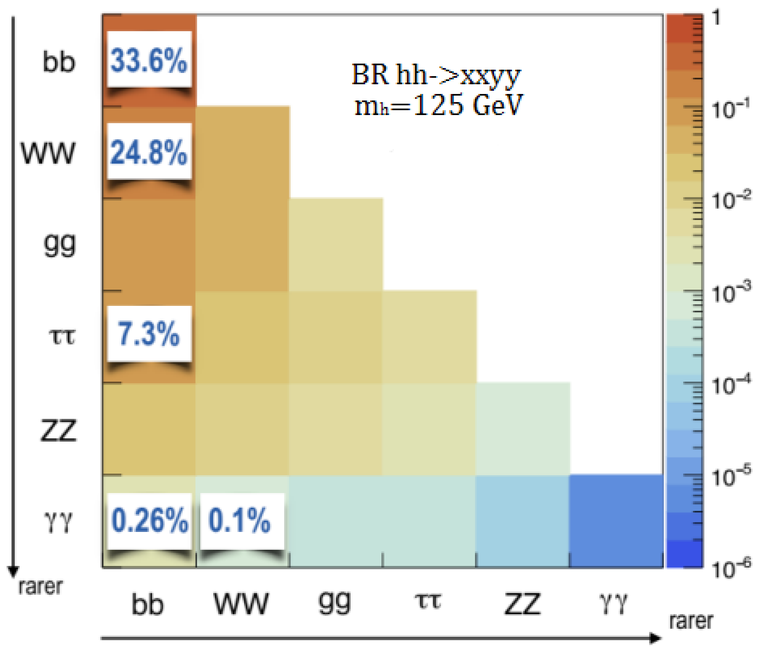
In this work we describe the search for the Higgs boson pair production where one Higgs boson decays via *h→ bb(bar)* and the other via *h→WW*→lvqq*. The search is performed on full data set 2015(3.2 fb-1) plus 2016 (33.3 fb-1) of proton-proton collision data at the center of mass energy of 13 TeV recorded with the ATLAS detector at the LHC.

The SM predicts the interaction of the Higgs boson with itself. This mechanism contributes to the non-resonant Higgs boson pair production through Yukawa type interaction. Fig's (a) and (b) show the schematic diagram of the non-resonant Higgs boson pair production.



Di Higgs Branching Ratios

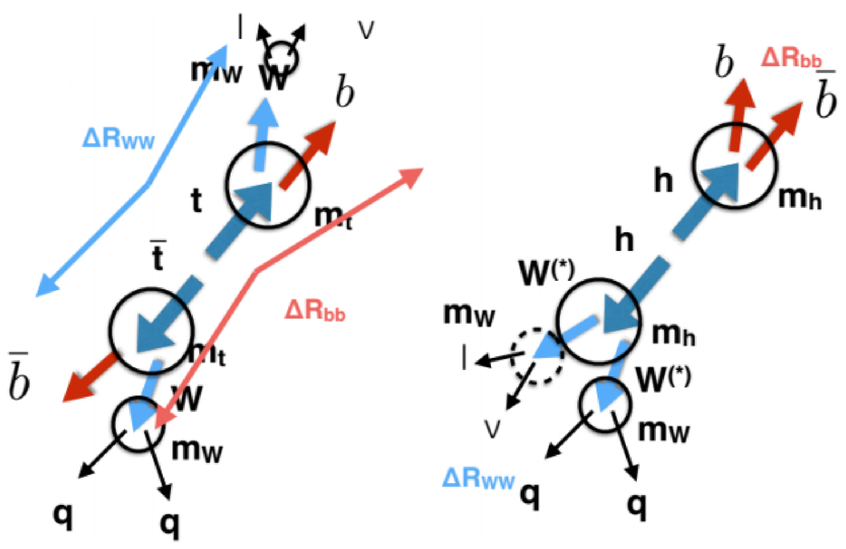
1) 6 decay channels are under study by ATLAS
2) 4b has the largest Branching Ratio
3) WWbb is the second largest Branching Ratio
4) The full hadronic decay of the WW pair has higher branching ratio respect to the semi-leptonic, but it is affected by larger QCD background.



Signal Vs Background

1) tt(bar) is the largest and irreducible background
2) Other backgrounds are W+jets, Z+jets and Di-bosons
4) Nevertheless the decay kinematics can be used to distinguish between signal and background.
5) Largest separation is expected when: $m_{hh} >> m_{tt(bar)} = 350$ GeV

3) The signal topology consists of one charged lepton, four jets two of which are b-jets and missing transverse energy

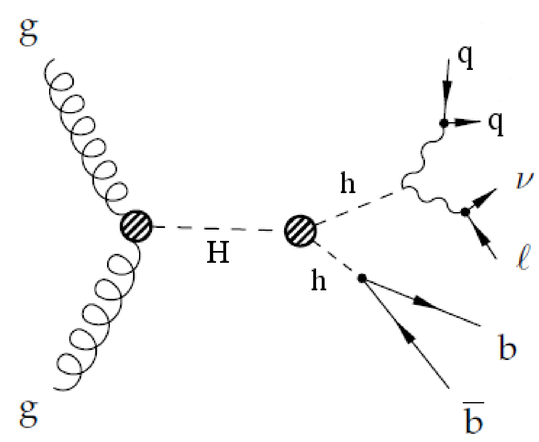


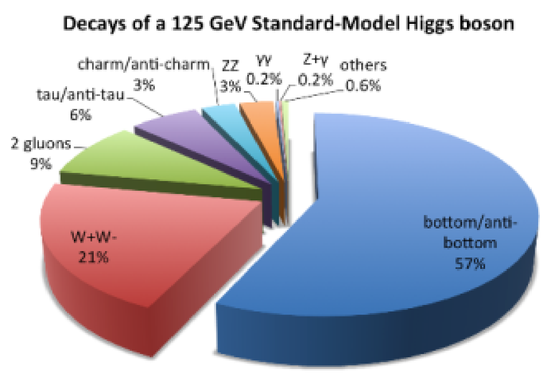
Conclusion

- By adding lepton plus jets trigger, we get a 40% efficiency gain over the single lepton trigger alone.

The Physics Process

Di Higgs production can proceed also through BSM Physics, like the exchange of a heavy Higgs boson (H).





Used Triggers

- **Purpose of Study:** Trying to increase the signal acceptance by adding lepton plus multi jet triggers instead of 1 lepton triggers.

1Lepton Triggers:

- passHLT_e26_lhmedium_nod0_ivarloose
  It triggers on electron of threshold 26 GeV.
- passHLT_mu26_ivarmedium
  It triggers on muon of threshold 26 GeV.

1Lepton and 3 jet Triggers:

- passHLT_e15_lhtight_ivarloose_3j20_L1EM13VH_3J20
  It triggers on tight electron & jets of threshold 15 & 20 GeV
- passHLT_mu14_ivarloose_3j20_L1MU10_3J20
  It triggers on muon & jets of threshold 14 & 20 GeV respectively and the isolation criteria are applied at trigger level which depend on the lepton pT. The ivarloose and ivarmedium are the looser and tighter criteria respectively applied at the HLT level.

Cuts Applied

- **Preselection:**
  - **Muon:** |η| < 2.5, pT>15 GeV
  - **Electron:** pT>16 GeV, |η| < 2.47
  - **Jets:** Algorithm anti-K_t, radius 0.4, |η| < 4.5 , pT >20 GeV,
    b-tagging efficiency= 85%
- **h→bb, 2 b-Jets:** 2 Jets are required to be b-tagged to identify the h→bb decay.
- **nCentralLightJets>=2:** This requirement asks for jets from the W decay. Detected in the central part of the detector
- **Selection:** $m_{bb} < 130$ GeV, $P_t^{bb} > 150$ GeV, $\Delta R_{bb} < 1.1$, $\Delta R(WW) < 0.9$, $105 < m_{bb} < 135$ GeV

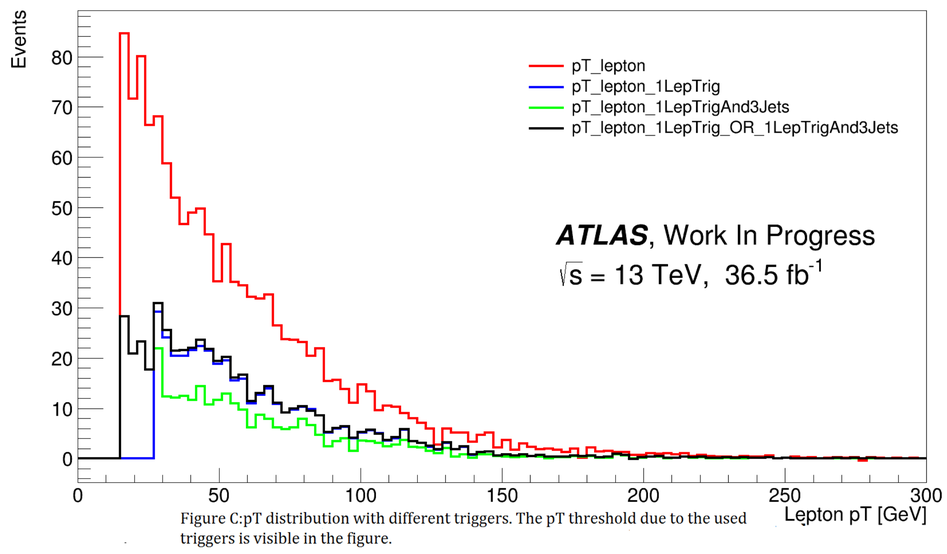


Figure C:pT distribution with different triggers. The pT threshold due to the used triggers is visible in the figure.

	Trigger Efficiencies			
Cut	1LepTrig	1LepAnd3JetsTrig	1LepTrig_OR_1LepAnd3JetsTrig	Relative gain (%)
Presel	0.322±0.007	0.268±0.007	0.403±0.007	25
H→bb Jets>=2	0.322±0.007	0.268±0.007	0.403±0.007	25
nCentralLightJets >=2;	0.318±0.007	0.287±0.007	0.406±0.008	27
bJets>=2	0.192±0.006	0.186±0.006	0.249±0.007	29
Selection	0.319±0.044	0.441±0.046	0.449±0.046	40