

$H \rightarrow ZZ \rightarrow l^+l^-b\bar{b}$ at High Mass

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Introduction

- Investigate channel $H \rightarrow ZZ \rightarrow l^+l^-b\bar{b}$
- Main high mass channel is $H \rightarrow ZZ \rightarrow l^+l^-l^+l^-$, but $\text{BR}(Z \rightarrow b\bar{b})/\text{BR}(Z \rightarrow l^+l^-) = 4.5$.
so $\text{BR}(ZZ \rightarrow l^+l^-b\bar{b})/\text{BR}(ZZ \rightarrow l^+l^-l^+l^-) = 4.5$
We should try and use this channel if we can!
- Backgrounds are higher but efficiencies similar. Good cross-check of 4 lepton channel.
- Doesn't look well covered recently at ATLAS. Paper by G. Martinez et. al. from 2003 on low mass higgs but I couldn't find anything else more recent.
- I perform a 'standard' analysis with standard jets, b tagging, lepton cuts etc.

Monte Carlos

- Using mc08 files with $\sqrt{s} = 10$ TeV cross sections but scaled to $\sqrt{s} = 14$ TeV cross sections to mimic high energy analysis
- Still waiting for official MCs requested last year. Barry has produced signal.
- We don't have enough $Z + b$ jet statistics. We get around this by scaling all jets by by MCFM ratio of di- b -jet events to di-jet events $\times \epsilon_b^2$ ($0.0068 = 0.019 \times 0.6^2$)

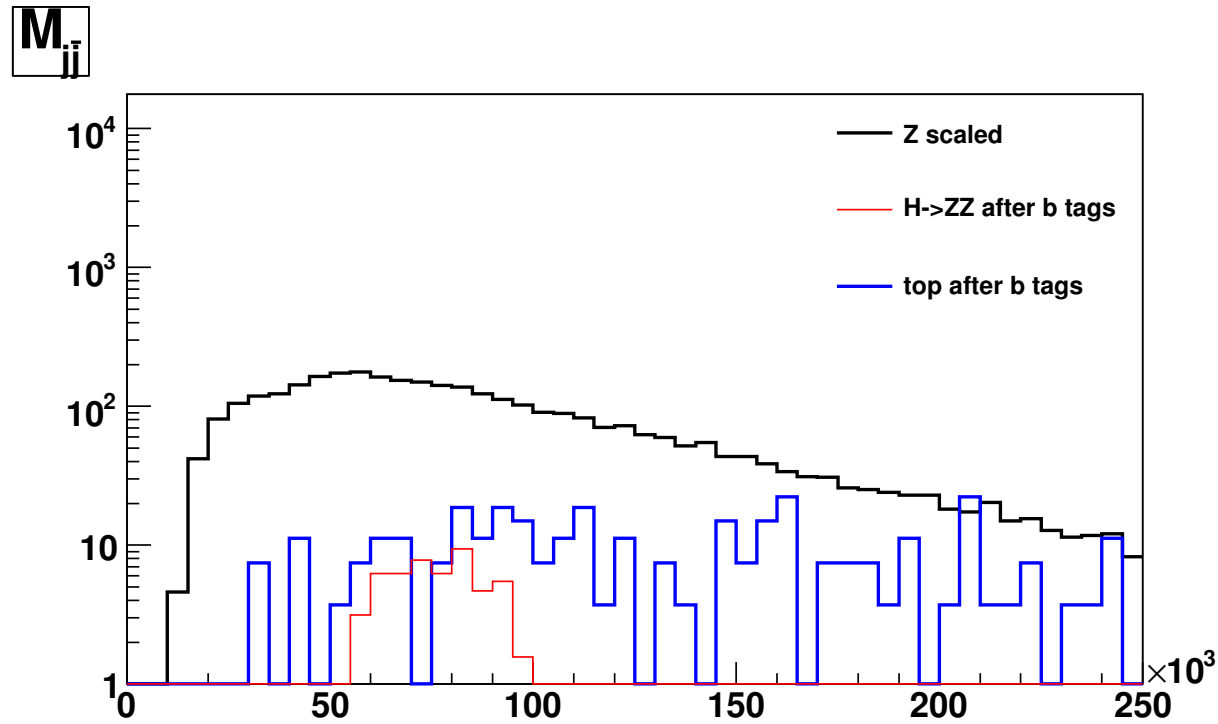
Monte Carlos $\sqrt{s} = 14$ TeV

- $H \rightarrow ZZ$, (private Gen from Barry only $M_H = 200$ GeV presently)
 $\sigma = 14.895 \times 0.261$ pb, $L=208$ fb $^{-1}$
- inclusive Z , $Z \rightarrow \mu^+ \mu^-$ lepton filter, includes Z +jets and Z + b jets, (PYTHIA 106050)
 $\sigma = 2015 \times 0.96$ pb
- inclusive Z , $Z \rightarrow e^+ e^-$ lepton filter, includes Z +jets and Z + b jets, (PYTHIA 106051)
 $\sigma = 2015 \times 0.96$ pb
- top, single lepton filter: $\sigma = 833 \times 0.539$ pb,
 $L=247$ pb $^{-1}$ (AcerMC PYTHIA 105205)
 $L=244$ pb $^{-1}$ (AcerMC HERWIG 105206)
 $L=803$ pb $^{-1}$ (MC@NLO 105200)
- WZ , lepton filter, (HERWIG 5987)
 $\sigma = 7.8 \times 0.213$ pb, $L=48$ fb $^{-1}$
- ZZ , no files available yet desperately needed!

Event Selection

- Find electrons (“ElectronAODCollection”). $E_T^e > 20$ GeV, $|\eta^e| < 2.5$.
- Find Jets (“Cone4H1TowerParticleJets”). Cone size 0.4. $E_T^{jet} > 20$ GeV, $|\eta^{jet}| < 2.5$.
Exclude those close to an electron $\Delta R > 0.4$.
- Find muons (“StacoMuonCollection”). $E_T^\mu > 15$ GeV, $|\eta^\mu| < 2.5$.
Exclude those close to a jet $\Delta R > 0.4$.
- Require $MET < 30$ GeV.
- Require 1 tight lepton and 1 other tight, medium or loose lepton of same flavour, on shell $76 < M_{ll} < 106$ GeV.
- Require $2 \leq N^{\text{Jet}} \leq 4$.
- Require 2 b tags using cuts on ‘jet weight’ of > 5 .
Always keep 2 jets with highest weights as $H \rightarrow bb$ candidates
- Require 3rd jet to have a jet weight of < 0 .
- Invariant mass of b jets $60 < M_{bb} < 100$ GeV

DiJet Mass after b tagging



Clearly see a resonant Z peak in signal.

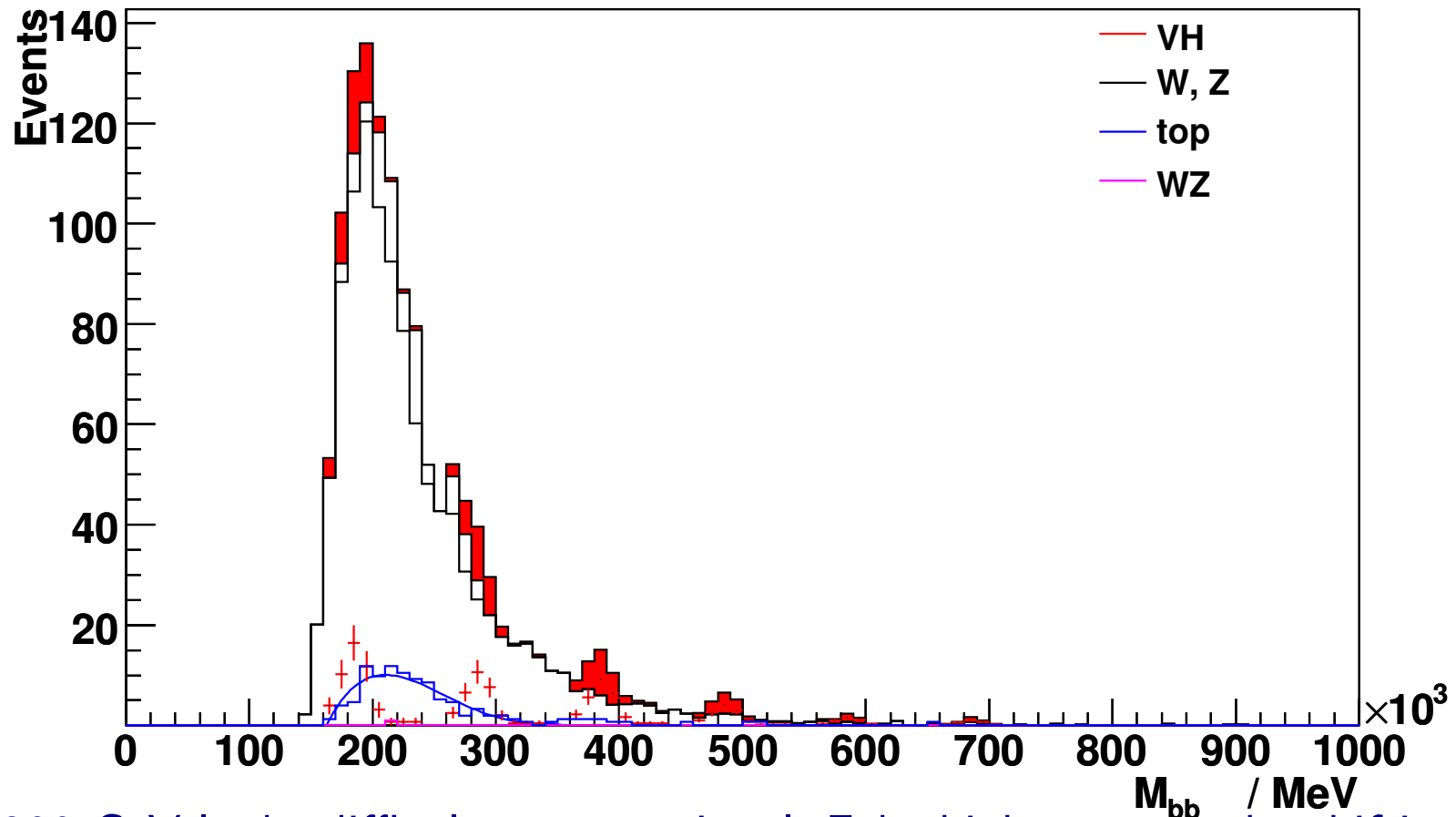
Can use the Z mass as a constraint.

Maybe can improve resolution further by using constraint of no missing E_T .

Backgrounds large.

Invariant Mass of $llbb$

M_{bb} after both NNs $L=10 \text{ fb}^{-1}$



At $M_H = 200 \text{ GeV}$ looks difficult to see a signal. Fake higher masses by shifting histogram up and scaling by $\sigma \times \text{BR}$.

Not a perfect procedure since efficiencies and resolutions will alter.

No use of the Z mass constraints was made. This will improve the analysis considerably.

Remember important ZZ background is not taken into account

Summary

- The $H \rightarrow ZZ \rightarrow l^+l^-b\bar{b}$ channel looks like it could add to the significance of Higgs discovery or exclusion at high mass.
- Simple cuts show that a resonance may be visible above the background for $M_H > 30$ GeV for a few fb^{-1} .
- No use of the Z mass constraints was made. This should improve the analysis considerably.
- Analysis preliminary and important ZZ background missing.

Extra Slides
