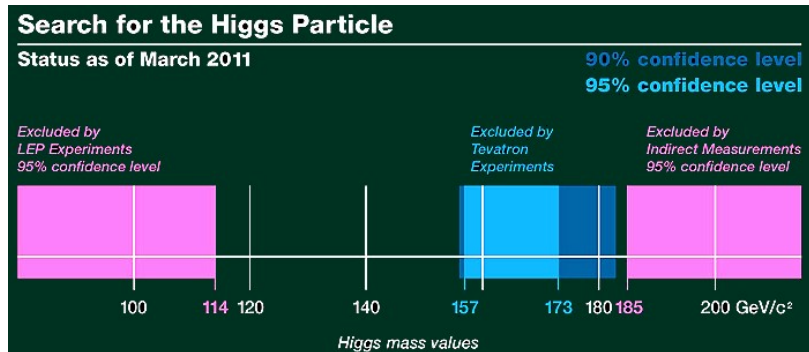


# Boosted Higgs Boson Search at LHC with Jet Trimming

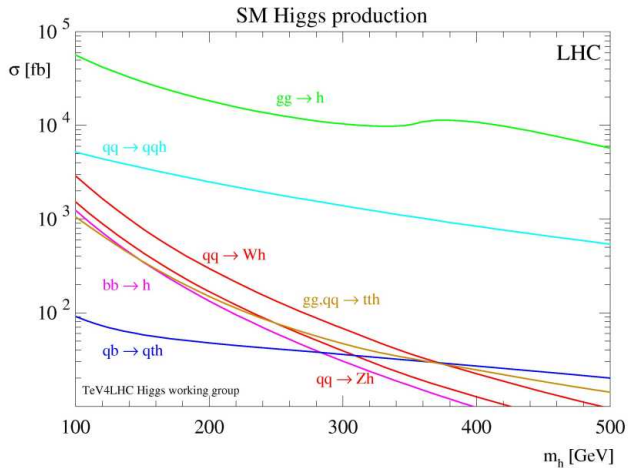
Wenhan Zhu  
Princeton University  
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May 10th, 2010

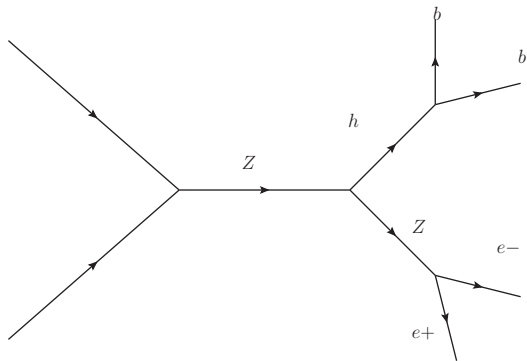
# Higgs Mass constraint



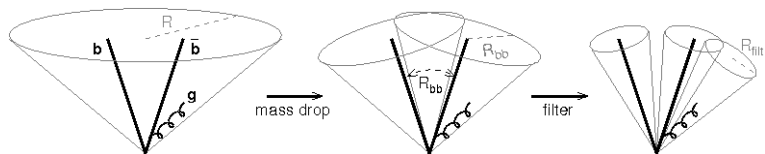
# Higgs Production



# WH/ZH search channel @ LHC



# Overview of Previous Search Strategy

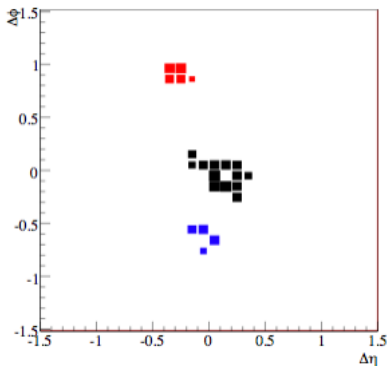
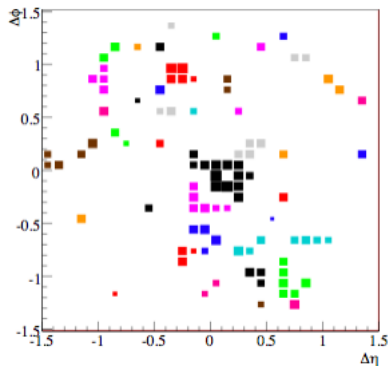


Butterworth, Davison, Rubin and Salam, *Phys.Rev.Lett.*100:242001,2008

- ▶ Boosted Higgs Candidate and Vector Bozon.
- ▶ Mass Dropping and Filtering on the Higgs Candidate.
- ▶ Require two tagged B in the Higgs Candidate.
- ▶ Veto any additional B and leptons in the event.

# Jet Trimming

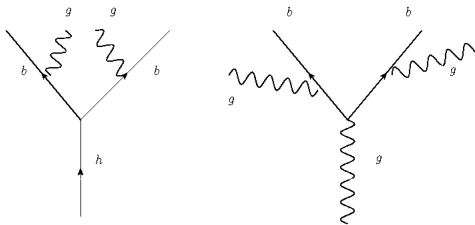
Krohn,Thaler,and Wang, JHEP 1002 (2010) 084 [arXiv:0912.1342]



# Jet Trimming

- ▶ Cluster all cells/tracks into jets using any clustering algorithm. The resulting jets are called the seed jets.
- ▶ Within each seed jet, recluster the constituents using a (possibly different) jet algorithm into subjets with a characteristic radius  $R_{\text{sub}}$  smaller than that of the seed jet.
- ▶ Consider each subjet, and discard the contributions of subjet  $i$  to the associated seed jet if  $p_{Ti} < f_{\text{cut}} \cdot \Lambda_{\text{hard}}$ , where  $f_{\text{cut}}$  is a fixed dimensionless parameter, and  $\Lambda_{\text{hard}}$  is some hard scale chosen depending upon the kinematics of the event.
- ▶ Assemble the remaining subjets into the trimmed jet.

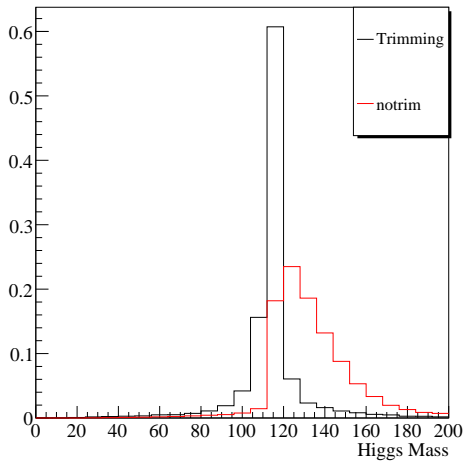
# Jet Trimming



- ▶ Cluster the particles in the hardest jet with a smaller cone size 0.3 with anti- $k_T$  algorithm to find out the hardest two subjets, and we will require b tagging on each of the two subjets.
- ▶ If  $p_T^i > f_{\text{cut}} p_T \Delta R$  the minijet is kept else it is trimmed,  $\Delta R$  is the distance between the subjet and the fat jet.



# Jet Trimming



# Event Generation and Analysis

## Channels:

- ▶ Signal:  $HW, HZ$  with  $H \rightarrow b\bar{b}, Z \rightarrow l^+l^-, Z \rightarrow \nu\bar{\nu}, W \rightarrow l\nu$
- ▶ Background:  $VV, Vj, jj, t\bar{t}$

## Cuts:

- ▶  $p_{tV}, p_{tH} > 200 \text{ GeV}$   $|\eta_H| < 2.5$
- ▶  $p_{tH} > 30 \text{ GeV}, |\eta_l| < 2.5$
- ▶ no extra  $l, b$  with  $|\eta| < 2.5$

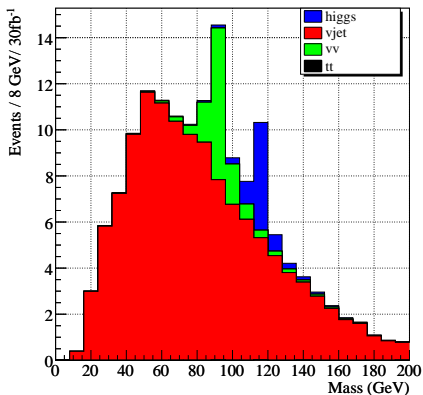
## Assumption:

- ▶ Real/Fake  $b$  tag rates: 0.6/0.02
- ▶  $S/\sqrt{B}$  from 16 GeV mass window (112-128 GeV) for  $30 \text{ fb}^{-1}$  luminosity

## Tool:

- ▶ Tool: Pythia 6.4.21 ("DW Tune"), FastJet 2.4.2

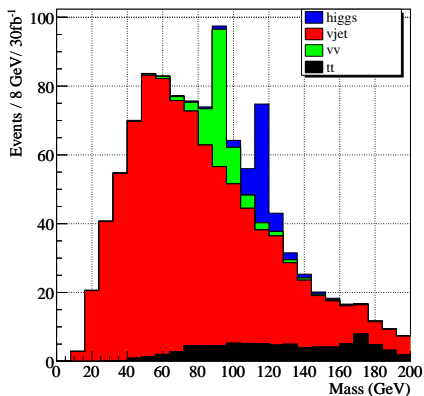
# Leptonic Channel



Channel specific cut:  $80 < m_{l+l^-} < 100$  GeV

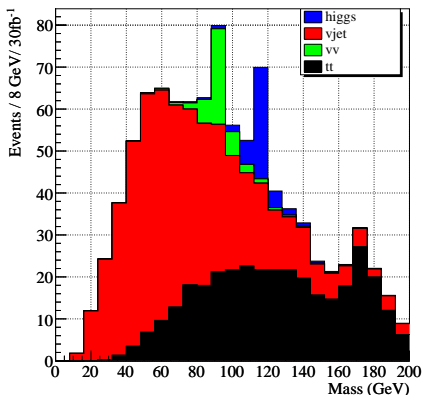
$S/\sqrt{B}=1.7$  in 112-128 GeV

# Missing $E_T$ Channel



Channel specific cut: Missing  $E_T > 200$  GeV  
 $S/\sqrt{B}=2.7$  in 112-128 GeV

# Semi-leptonic channel Channel

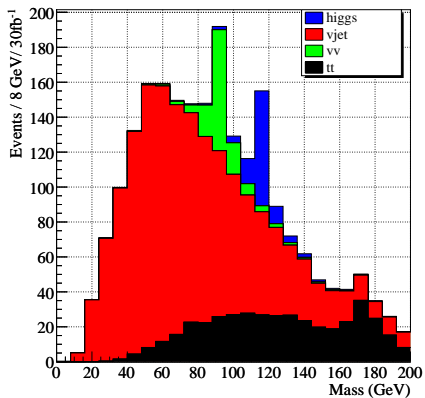


Channel specific cut: Missing  $E_T > 30$  GeV, no extra jets

$|\eta| < 3, p_T > 30$

$S/\sqrt{B}=3.3$  in 112-128 GeV

# All Channel



$S/\sqrt{B}=4.5$  in 112-128 GeV

# Conclusion

- ▶ Jet Trimming is very powerful tool in removing ISR/MI/PU contamination.
- ▶ Boosted Higgs Boson search channel is a promising channel at the LHC.
- ▶ The statistical significance is 4.5 for 30  $fb^{-1}$  luminosity.