Search for H→hh→4W in same sign leptons at LHC

Wei-Ming Yao (LBNL)
With Hong-Jian He, Ren Jing,Rui-Qing Xiao

Yaquan Fang's group meeting, 11/16/2015

Motivation and Event Selections

•Investigate the feasibility for search for H→hh→4W in same sign lepton channel at HL-LHC using two-Higgs-Doublet-Model (THDM).

• The studies by Baur, Plehn, and Rainwater in PRL 89 (2002), 151801 seem interesting and could be useful for discovery heavy Higgs at HL-LHC running.

•Monte Carlo Samples:

- Generated using Madgraph (v1_5_14) + Pythia + Delphes simulation.
- Signal model: Hheft-300GeV_UFO with cross section normalized at 471 fb
- Backgrounds generated:
  - tth→lepton+jets +h→ww
  - ttV→lepton+jets + V→(lv,ll)
  - whjj→lv+h→ww+jj (dominated in wwwjj)
  - $W^{\pm}W^{\pm}$4j + Detector related backgrounds not included yet.

•Event Selections:

- Two Isolated same sign leptons: leading Et>20 GeV and subleading Et>10 GeV
- >=4Jets with Et>20 GeV and |eta|<2.5
- Requiring h→ww→lvj1j2 where l is closet to j1 or j2, same for other h.
- BDT training H→hh vs ttW

•Challenges:

- Missing neutrinos, can not reconstruct the mass, have to reply on BDT.

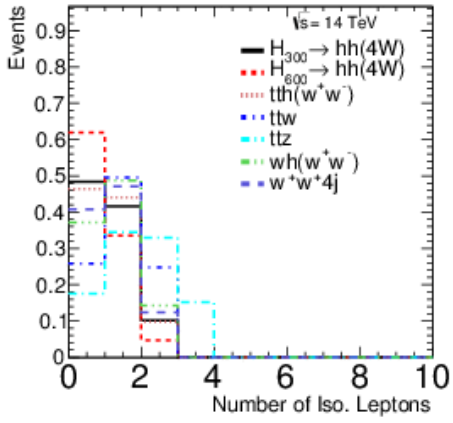
Process Cross Sections

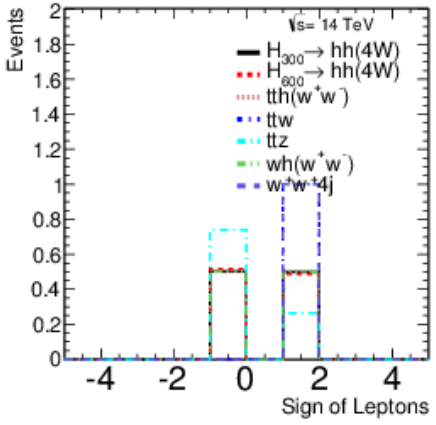
•Cross sections are computed LO including h→ww and w decay branching ratios and k-factors.

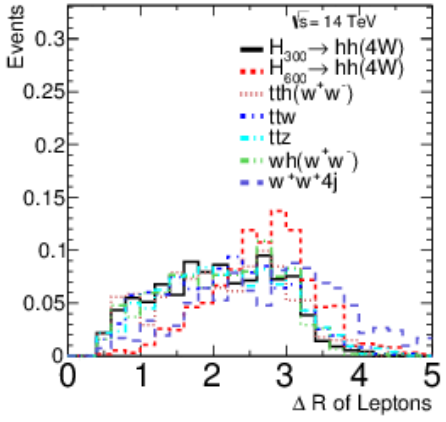
Samples	Cross Section(fb)	Number of Events
H(300)→hh	93	100000
H(600)→hh	20	100000
tth	15.1	100000
ttW	20.0	100000
ttZ	16.0	100000
whjj	6	35220
w^+w^+4j	8.7	6052

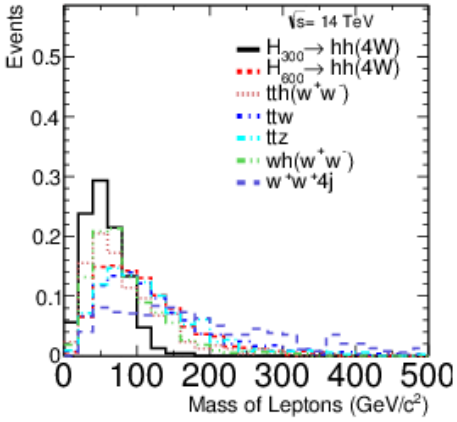
Kinematic Distributions-1

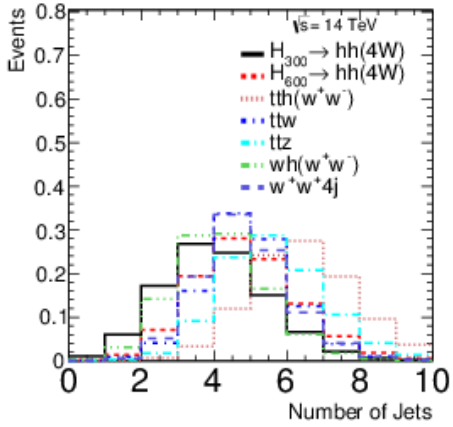
- Left: Number of leptons, sign of two leptons, njets and number of bjets.
- Right: dR, mass of leptons, dR of lepton and jets.

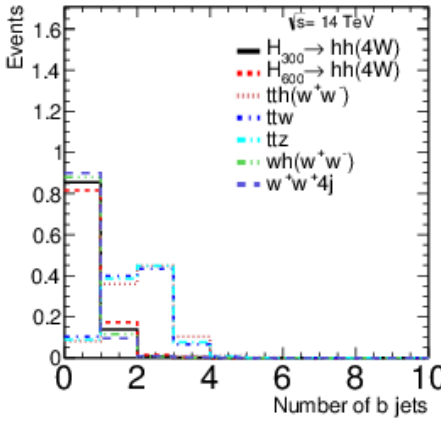


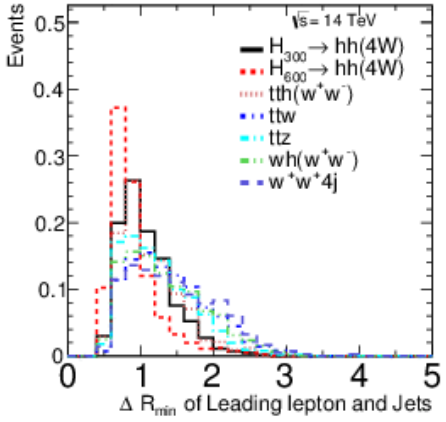


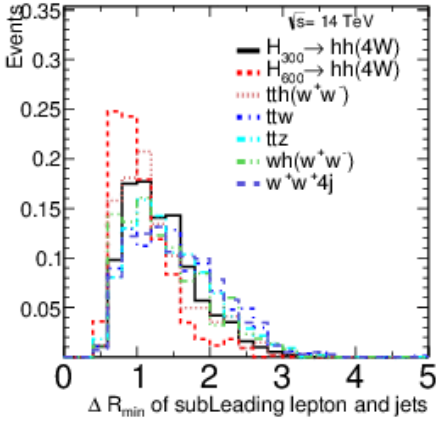






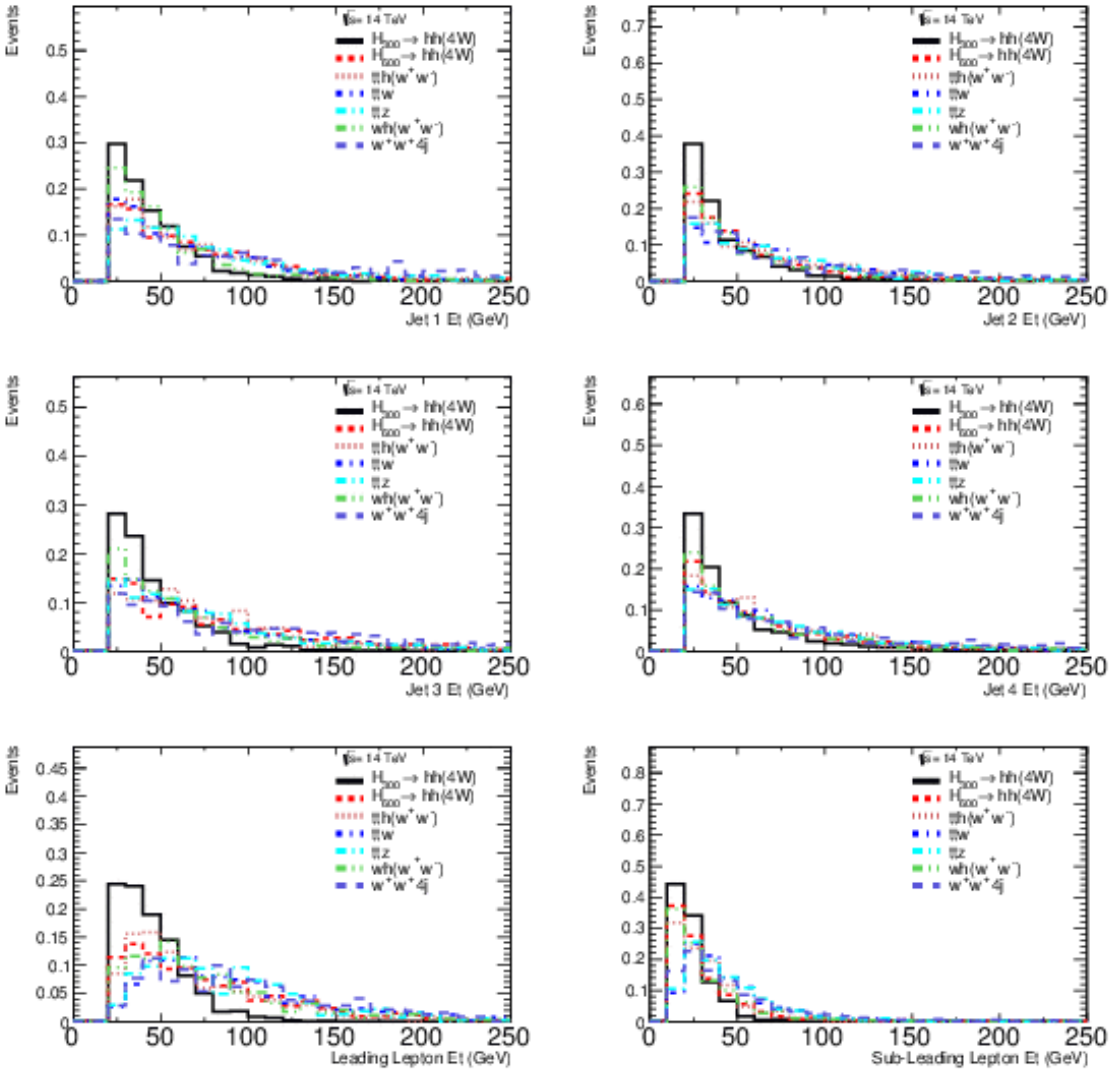






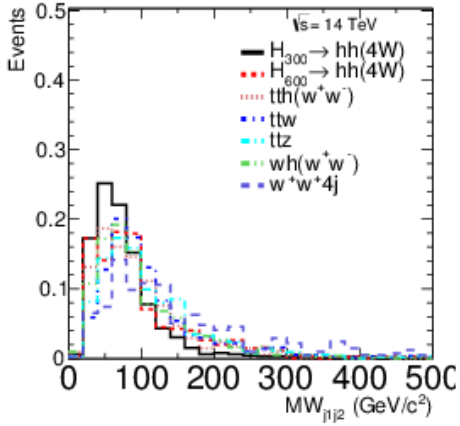
Kinematic Distributions-2

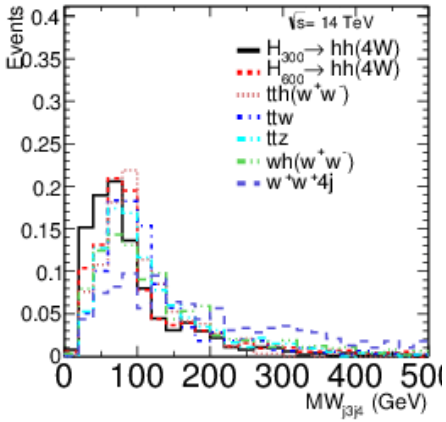
- Leading 4 jet Et and leptons Et.

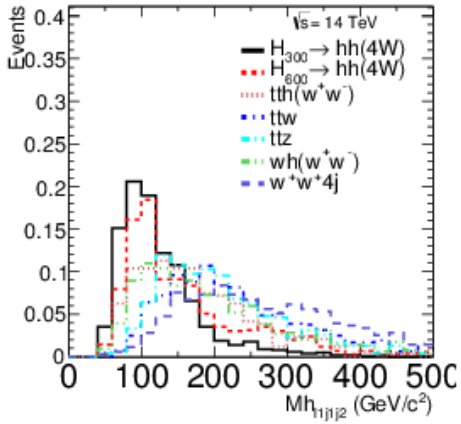


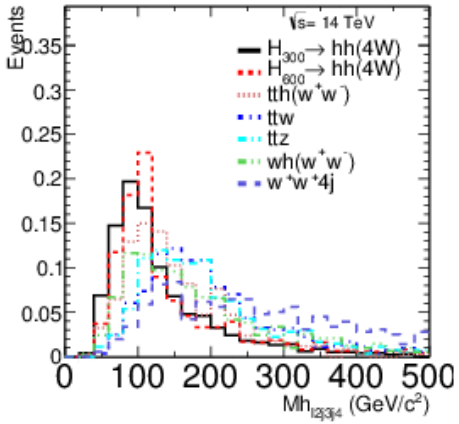
Kinematic Distributions-3

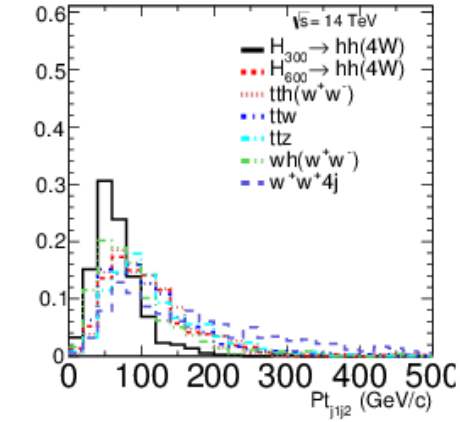
- Left: reconstructed two Wmass and Pt .
- Right: reconstructed two higgs, and H→hh mass and Pt.

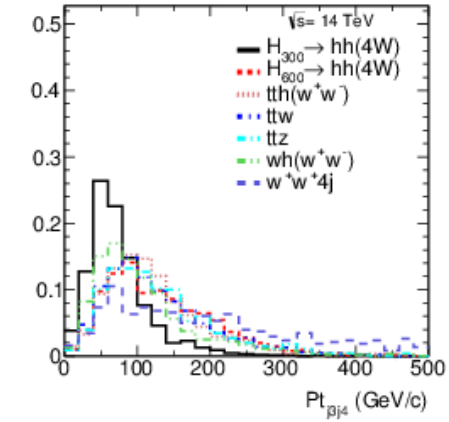


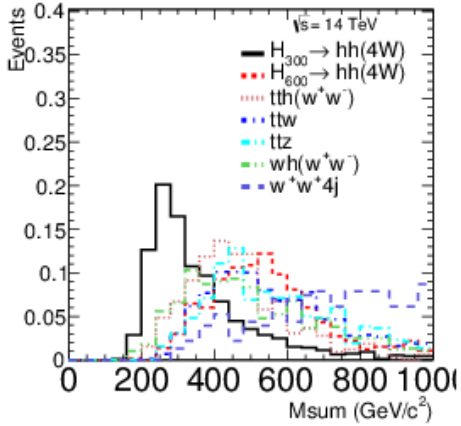


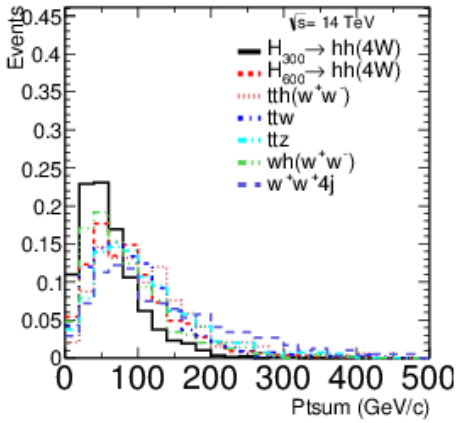






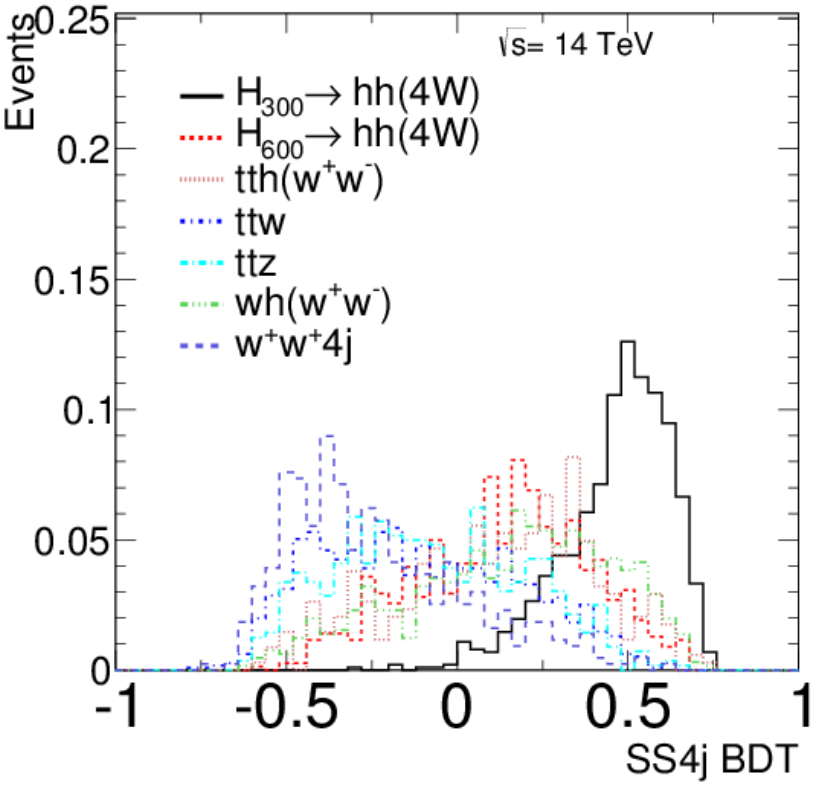


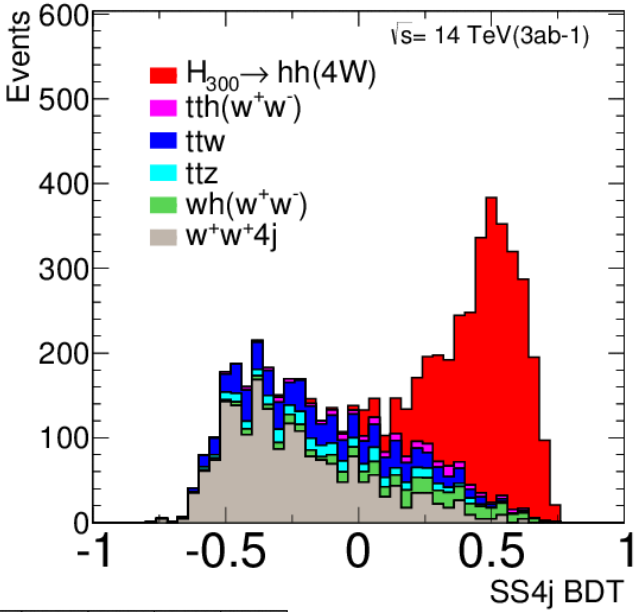


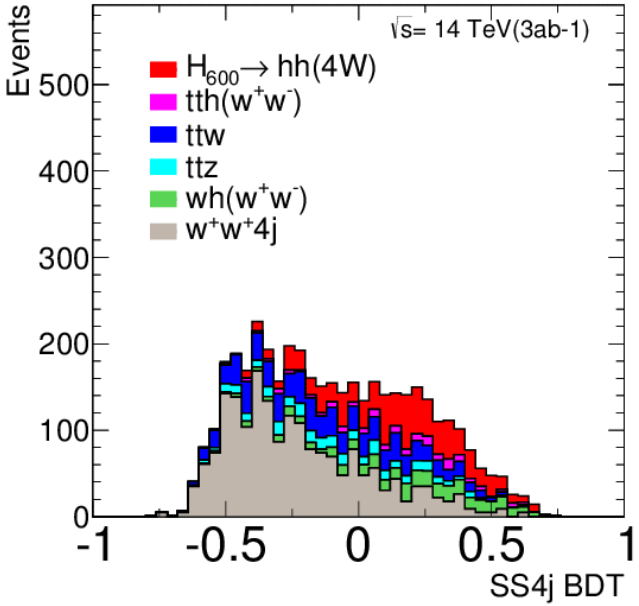


BDT Discriminator

- Left: Trained BDT discriminator using H→hh vs ttW.
- Right: Expected events for mH2=300,600 GeV out of 3000 fb-1 data.







Next Step

- The results seems promising to discover the extra Higgs in two Higgs doublet model.
- Double check the cross sections and other masses.
- The kinematic of heavy Higgs looks more consistent with the background that we may have to retrain the BDT for a given mass.
- Including other background from fakes
- Set the exclusion limits in two Higgs doublet model phase space.