First look at VBF Higgs, H -> ZZ -> llvv @ 10TeV

Jian Wang

IHEP,Beijing/Fermilab

Introduction

- Signal
  - qqH, H -> ZZ -> llvv, l = mu or e
    - Medium mass: 200GeV
    - High mass: 400/600GeV
  - Two equal flavor, opposite sign leptons in central region
  - High MET from decay Z->vv
  - No additional jet activity in central region
  - Tagging jets
- Backgrounds
  - Z+jets (for medium mass Higgs)
  - tt+jets
  - ZZ/WZ+jets

Signal and background samples

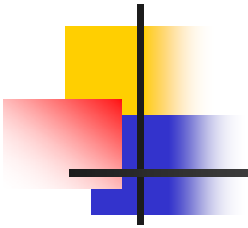
Signal samples are generated by Pythia and reconstructed by CMSSW22X.
Background samples are taken from official Summer08 Production.

	Xsection/pb	Events #	equivalent lumi/fb^{-1}
Z+jets	3700	1297404	0.350
tt+jets	317	905220	2.85
ZZ+jets	10.5	199810	19.0
WZ+jets	32	236550	7.40
qqH, H -> ZZ			
H200	0.3200	3000	
H400	0.1110	2900	
H600	0.0397	2300	

Branch ration for ZZ->llvv is 4.0%

Preselections (processed by Haifeng)

- Trigger
  - di-mu stream, di-e stream
- Lepton-isolation
- Lepton-selection
  - 2 leptons with Pt > 20GeV, opposite charged
  - No extra lepton with Pt > 10GeV
- Leptonic Z
  - di-lepton mass window: $\pm$12GeV of Z mass



- Jet topology
  - Electron-jet removal
  - Jet+track correction
  - At least 2 jets with Pt > 15GeV
  - MET corrected with muons

- Loose FJT
  - Jets Pt > 15GeV, $\Delta\eta > 3.0$, $\eta_1 * \eta_2 < 0$, $M_{jj} > 300$GeV
  - If more than one pair of candidate, select one that gives highest M_{jj}

Preselections efficiency

Higgs mass = 200GeV

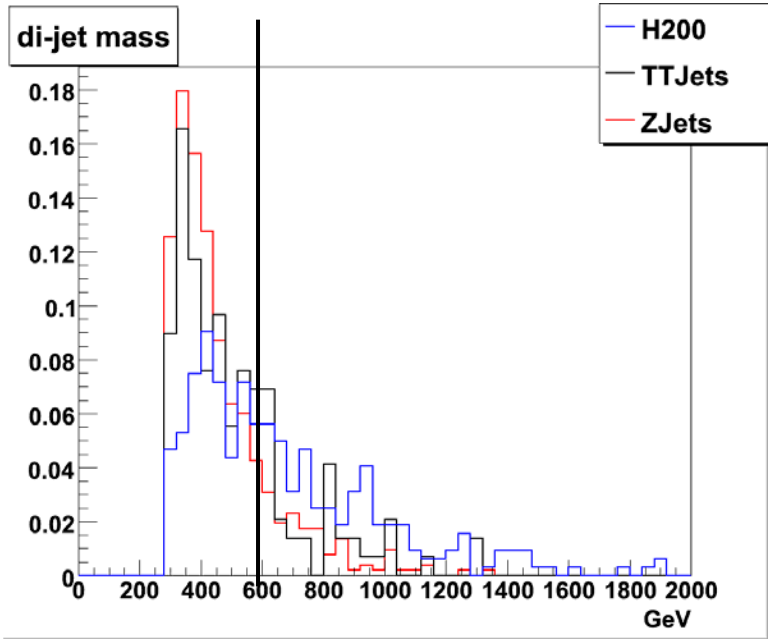
	di-mu channel	di-e channel
Trigger	0.575	0.575
Lepton-isolation	0.939	0.939
Lepton-selection	0.441	0.289
Leptonic-Z	0.934	0.932
Jet topology	0.871	0.904
FJT	0.553	0.568
Overall	0.107	0.075

	H200	Zjets	ttjets	ZZjets	WZjets
Initial	12.8	3700k	414k	10.5k	32k
Pre-select	2.33	2447	92.1	18.0	29.1

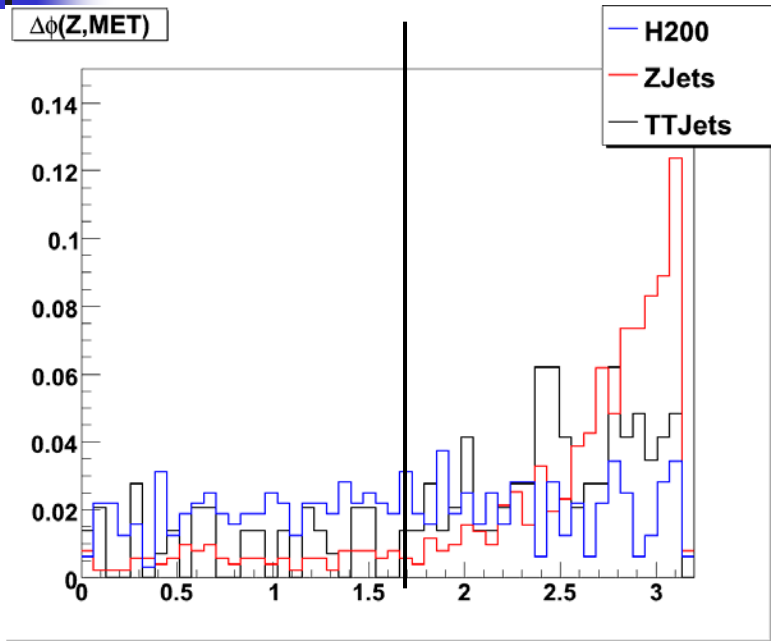
X-sections are in fb

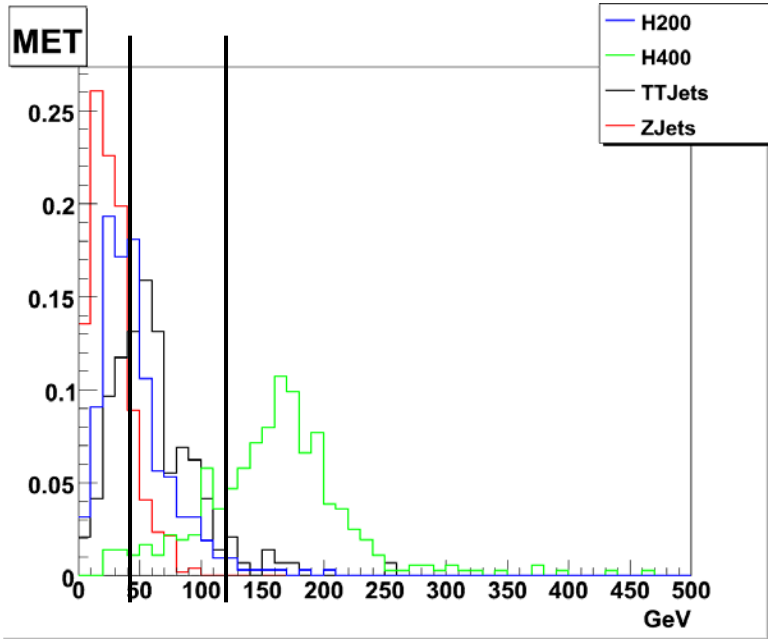
Jets

- Tag jets Pt > 30GeV
- M_{jj} > 600GeV
- Central jet veto
  - Reject event with jet Pt > 30GeV in $|\eta|<2.0$ region



Z boson & MET





ΔΦ(Z,MET) < 1.7

Medium mass Higgs case: MET > 40GeV
High mass Higgs case: MET > 120GeV

Summary of cuts for medium mass Higgs

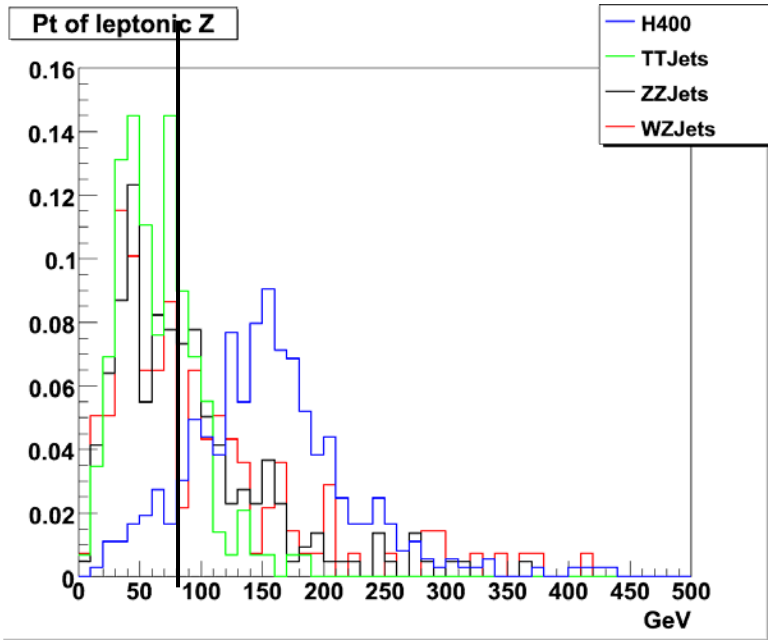
- Preselections
- Tag jets Pt > 30GeV, M_{jj} > 600GeV
- Central Jet Veto
- $\Delta\Phi(Z,MET) < 1.7$
- MET > 40GeV

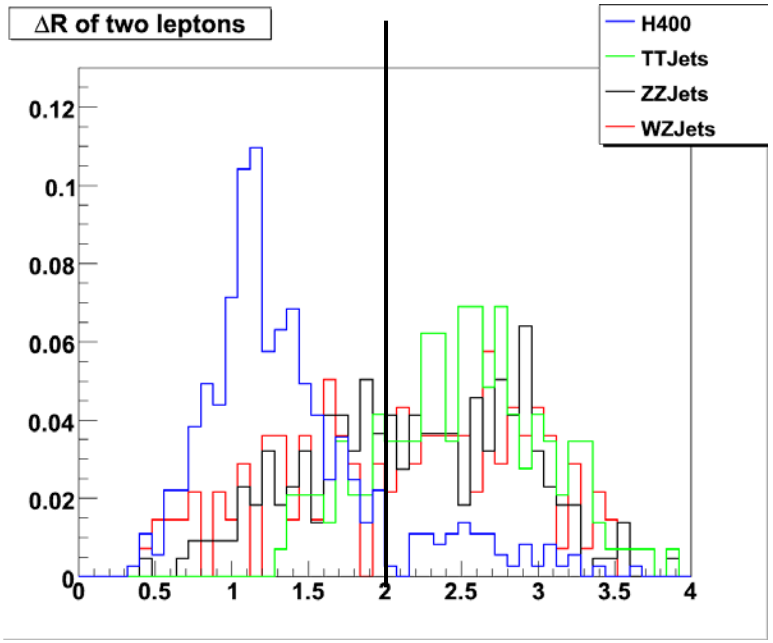
- After these cuts, we have no background events left
  - Backgrounds are huge in x-section and have similar topology with signal (Zjets is still 3 orders of magnitude larger than singal after preselection). So we have to apply tight cuts and get extremely low efficiencies.
  - Background samples have small statistics (Zjets ~ 0.35/fb)

Z+jets background estimation

- Factorized method (just assuming jet cuts and Z/MET cuts are independent with each other)
  - $\sigma_{final} = \sigma_{initial} * \varepsilon_{overall} = \sigma_{initial} * \varepsilon_{jet} * \varepsilon_{z/met}$
- Signal 0.34fb, Zjets 1.28fb
- Difficult to do further error analysis or data-driven analysis without MC background events
- Larger background samples needed

High mass Higgs case





Leptonic Z Pt > 80GeV

ΔR(ll) < 2.0

Summary of cuts for high mass Higgs

- Preselections
- MET > 120GeV
- Leptonic Z Pt > 80GeV
- ΔR(ll) < 2.0

	H400	H600	ttjets	ZZjets	WZjets
Initial	4.44	1.59	414k	10.5k	32k
Pre-select	0.90	0.33	92.1	18.0	29.1
Final	0.63	0.30	0.35	0.16	0.27
Significance @30/fb	3.5	1.8			

Prospect

- Medium mass Higgs case
  - Larger background samples needed
  - Improve preselections and cut based analysis, aiming for higher signal efficiency
  - Try other advanced techniques than cut based analysis
- High mass Higgs case
  - Looks promising
  - Could be an important part of inclusive H analysis