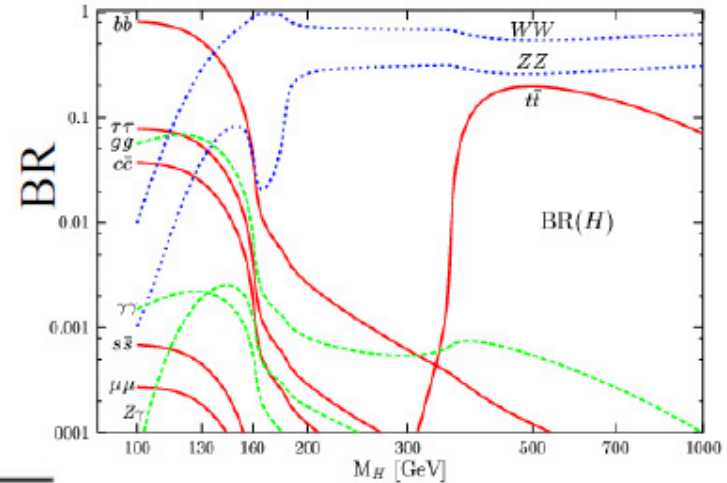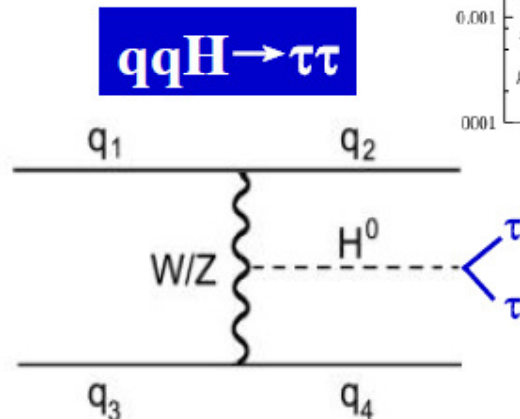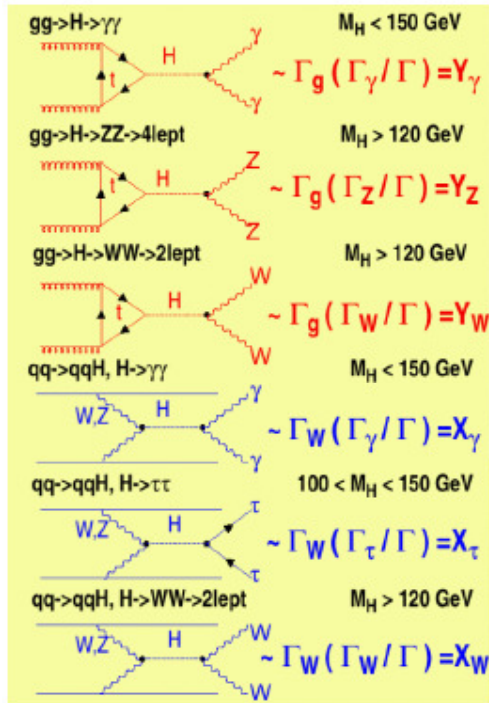# Search for the Standard Model Higgs boson produced in VBF decaying into τ pair in CMS with 1 fb^{-1}

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Outline

- Motivation
- Higgs Production via VBF
- Event Selection
- Results
- Summary

Motivation to study VBF Higgs Production

gg->H->γγ	$M_H < 150$ GeV
	$\sim \Gamma_g(\Gamma_\gamma/\Gamma) = Y_\gamma$
gg->H->ZZ->4lept	$M_H > 120$ GeV
	$\sim \Gamma_g(\Gamma_Z/\Gamma) = Y_Z$
gg->H->WW->2lept	$M_H > 120$ GeV
	$\sim \Gamma_g(\Gamma_W/\Gamma) = Y_W$
qq->qqH, H->γγ	$M_H < 150$ GeV
	$\sim \Gamma_W(\Gamma_\gamma/\Gamma) = X_\gamma$
qq->qqH, H->ττ	$100 < M_H < 150$ GeV
	$\sim \Gamma_W(\Gamma_\tau/\Gamma) = X_\tau$
qq->qqH, H->WW->2lept	$M_H > 120$ GeV
	$\sim \Gamma_W(\Gamma_W/\Gamma) = X_W$

qqH→ττ

q_1 q_2

W/Z H^0 τ
τ

q_3 q_4

BR(H)

Djouadi, Kalinowski, Spira

Significantly extend possibility of Higgs boson coupling measurements
Provide possibility of indirect measurement of light Higgs boson width

D. Zeppenfeld, R. Kinnunen, A. Nikitenko and E. Richter-Waz, Phys.Rev. D62 (2000) 013009
M. Duehressen et al., Phys.Rev. D70 (2004) 113009

Higgs Production via VBF
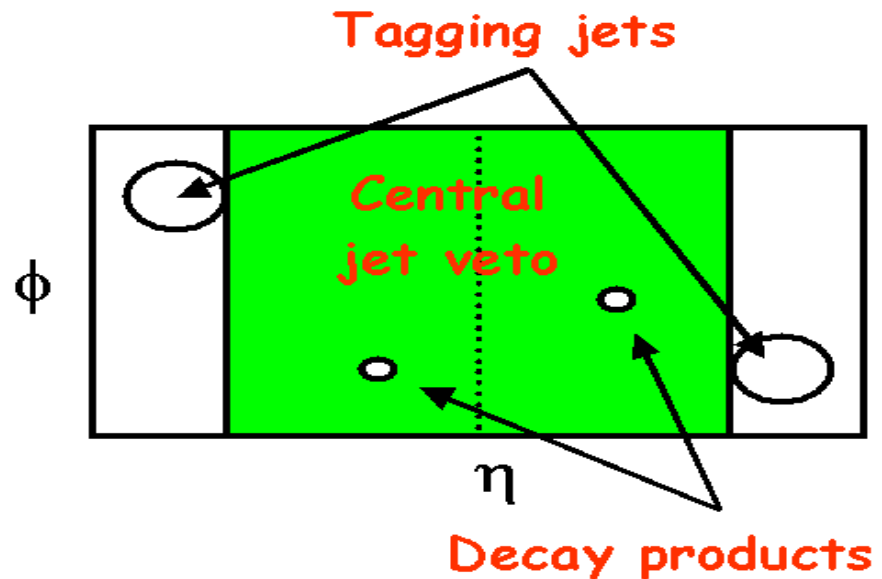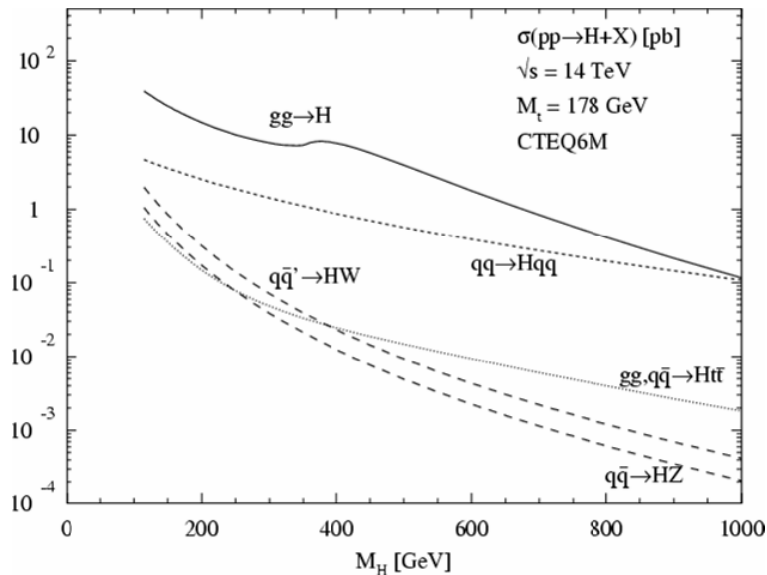
- Second largest Higgs production mechanism at LHC
- Two forward jets with little extra hadronic activity and the decay products of Higgs
- Central Jet Veto can reduce QCD backgrounds

Lepton Selection

Muon Selection

- P_T > 5 GeV and $|\eta|$ < 2.1
- Track Isolation: No track of in ring 0.02-0.3 with P_T > 1 GeV
- dz(muon) < 2 mm and 8 or more valid hits

Electron Selection

- P_T > 10 GeV and $|\eta|$ < 2.5
- Not in any ECAL crack
- Track Isolated: $\Sigma(P_T \text{ track})^2/(P_T \text{ electron})^2$ in a ring 0.02-0.25 < 0.005, for tracks with P_T > 1 GeV

Calo τ Jet Selection

- **Jet with leading track $P_T > 6$ GeV in $R_m = 0.1$**
- **1 or 3 tracks with $P_T > 1$ GeV in the signal cone**
- **total charge ±1 in $R_s = 0.07$**
- **no tracks with $P_T > 1$ GeV in $R_i = 0.45$**
- **ECAL isolation: ECAL $E_T < 3$ GeV in a ring 0.13-0.4 and be inside $|\eta| < 2.4$**
- **not matching the highest P_T electron or muon with $\triangle R < 0.3$**
- **if it has 1 track then it must not be in an ECAL crack**
- **$|\eta| < 2.4$**

Event Selection

- **single isolated lepton triggers(muon/electron)**
- **exactly one electron or muon passing the criteria**
- **lepton P_T>15GeV**
- **primary vertex candidate with lepton dz<0.2cm**
- **at least one τ passing above criteria**
- **if τ-jet has 1 track apply electron rejection criteria: $E_{T,3X3}$(HCAL) /P_T^{track}>0.1**
- **τ-jet P_T>30 GeV**
- **τ-jet and lepton are opposite sign**
- **at least 2 jets with E_T>30 GeV which do not match direction or lepton or τ -jet within ΔR<0.3**
- **2 highest E_T jets; $\eta^{j1}\cdot\eta^{j2}$< 0, $\Delta\eta$> 2.5 and M_{jj}>400 GeV**
- **the neutrino energy in the collinear approximation must be positive**
- **central jet veto: no jets with uncorrected E_T>10 GeV and α>0.1 between**
- **η^{jet1}+0.5 and η^{jet2}-0.5 which do not match the τ or lepton in ΔR<0.3**
- **transverse mass: 0 < M_T(lepton,MET) < 40 GeV to suppress W's**

Predicted ττ mass distribution with 1 fb⁻¹ at CMS
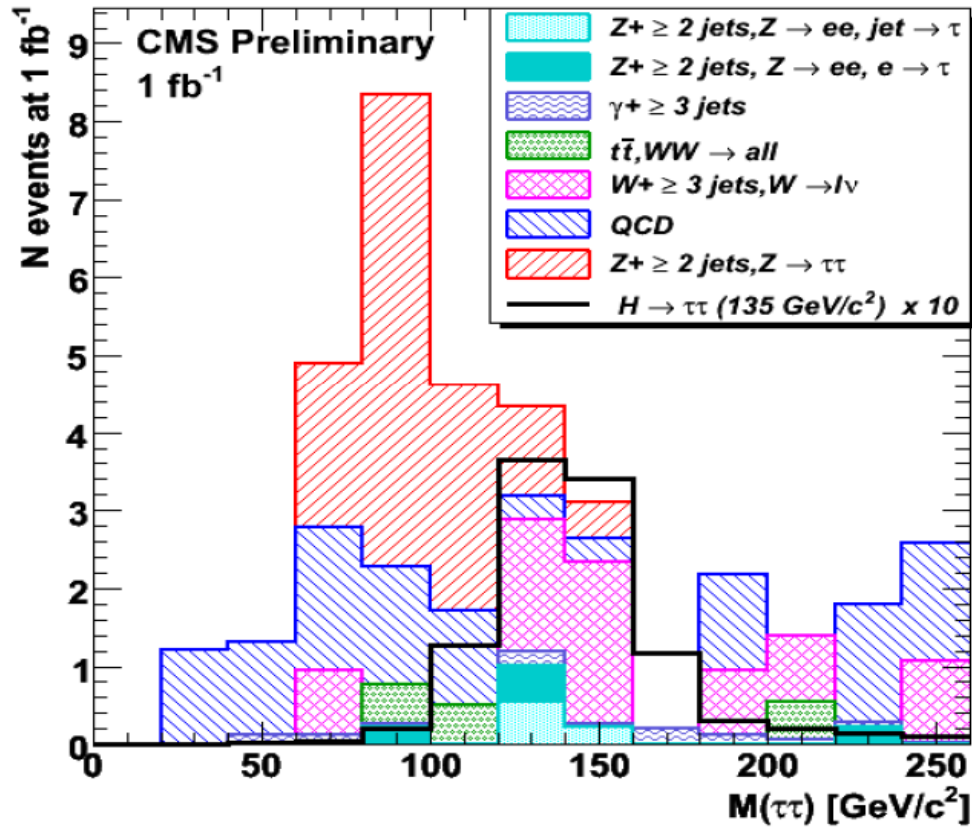
Full τ-pair mass using collinear approximation of neutrinos from the τ decays and the visible τ decay products
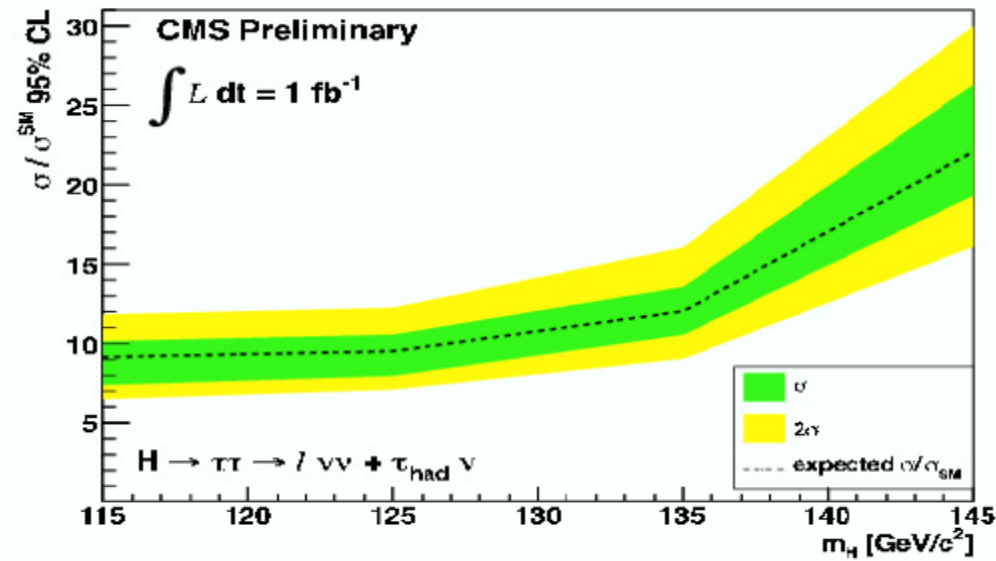
With 1fb⁻¹of data in the mass range from 115 to 145 GeV

- no signal evidence is expected
- upper limit on the cross section times the branching ratio is evaluated

Summary

- We develop a selection strategy for the Standard Model Higgs Boson produced in Vector Boson Fusion and decaying into a pair of τ lepton with $l\nu\nu+\tau_{had}\nu$ in the mass range 115 and 145 GeV/c^2 with 1 fb^{-1} of early CMS data at LHC

- No signal evidence is expected for luminosity of 1 fb-1 and an upper limit on the cross section times the branching fraction is calculated