Search of Standard Model Higgs Boson via WW decay channel using the CMS detector

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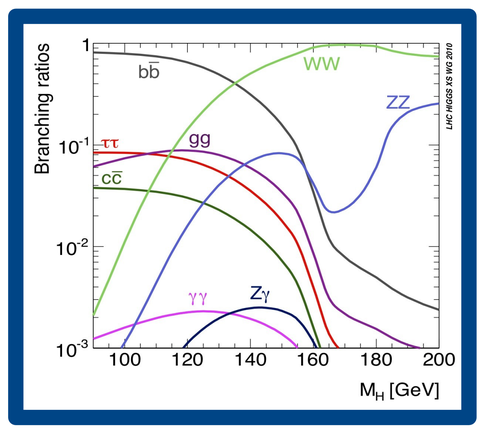
(On behalf of the CMS Collaboration)

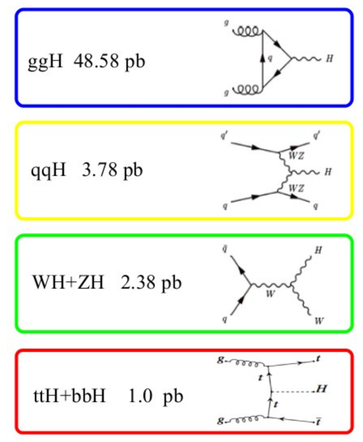
The Large Hadron Collider (LHC) & Compact Muon Solenoid (CMS) detector

- World's most powerful particle accelerator
- Accelerates and collides two counter rotating proton/Pb beams at very high energy
- Beams are made to collide @ 4 points corresponding to detector positions: ATLAS, CMS, ALICE & LHCb
- CMS: One of the two general purpose detectors aims to
- Study Standard Model (SM) at high energy
- Search/study Higgs Boson
- Search for the Beyond Standard Model particles
- One Higgs boson is found @ 125 GeV, Need to verify SM theory by measuring its properties precisely.

SM Higgs Boson Production & Decay Modes at LHC

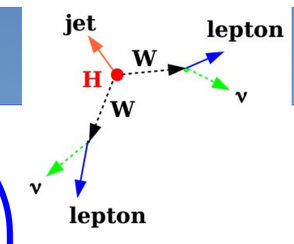
- Rich Higgs searches and studies progam @ LHC
- Gluon fusion (gg → H) is the dominant production mechanism at LHC
- "VBF", "VH", "ggH" and "ttH" allow to test H properties





- At 125 GeV → WW & $b\bar{b}$ decay channels have Largest Branching Fractions
- For a High Mass Higgs, H →WW, ZZ are the dominating ones
- γγ, ττ & ZZ are also exploitable at 125 GeV
- Measuring the properties of the 125 GeV Higgs Boson requires control of SM backgrounds

H → WW : Analysis Strategy



2.3/fb collected in 2015

Event Signature:

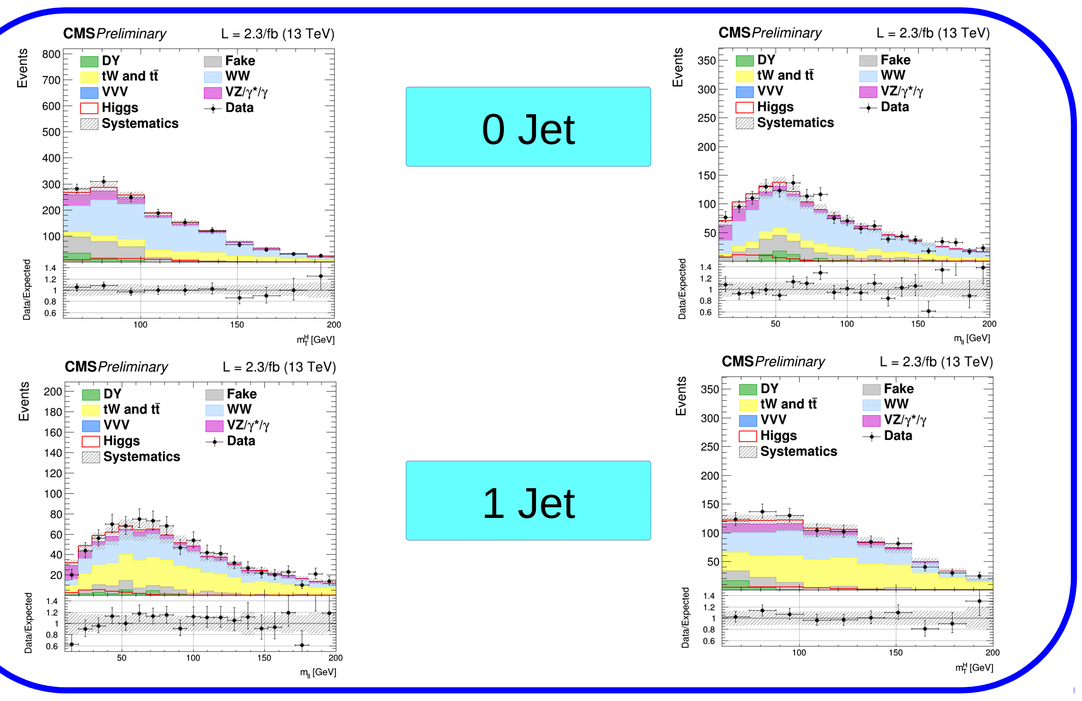
- Oppositely charged electron-muon pair with small opening angle
- Large Missing Transverse Energy coming from neutrinos
- Background composition varies w.r.t. number of jets
- 0 jets: WW, W+jets, 1 jet: WW, Top

Event Selection:

- Leading lepton p_T > 20 GeV, Trailing lepton p_T > 13 (10) GeV if electron (muon)
- Third lepton veto, m_{ll} > 12 GeV, p_T(ll) > 30 GeV, MET > 20 GeV
- 0 or 1 additional jet with p_T > 30 GeV

Neutrinos → impossible to reconstruct an invariant mass spectrum

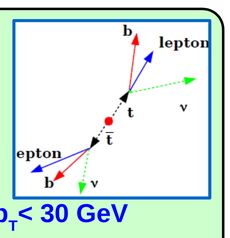
- Build a transverse mass variable: Di-lepton and MET system considered
- 2D template fit based on $m_{ll} : m_T$(ll, MET)



Background Estimation

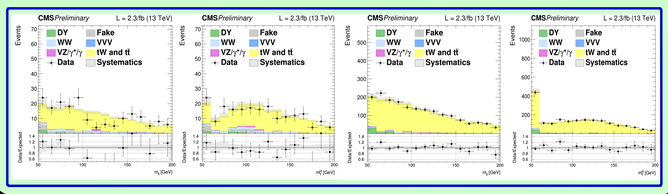
TOP

Top Control Region

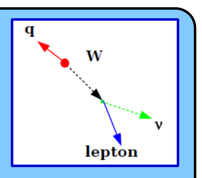


- WW selection but m_{ll} > 50 GeV & inverting b-veto
- 0-jet: at least 1 b-tag jet with 20 < p_T < 30 GeV
- 1-jet: exactly 1 b-tag jet with p_T > 30 GeV
- Top shape from MC & normalization from data

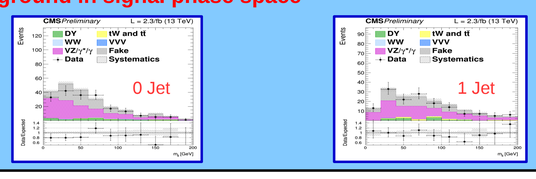
0 Jet 1 Jet



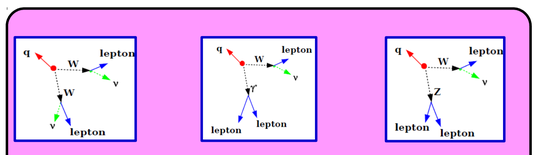
W+Jets



- W+jets and QCD multijets: Jet faking a lepton
- Measure the probability of jet faking as lepton (Fake Ratio)
- Measure prompt ratios, probabiity for a real lepton passing the loose lepton selection to also pass the tight one in a Z control region
- Extrapolation factor relates background in control region to the background in signal phase space

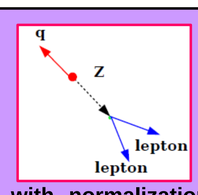


Diboson

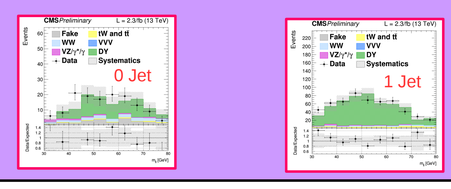


- gg to WW: Taken from MC predictions normalized to NNLO x-section
- VZ+VVV: All these backgrounds are taken from their MC predictions normalized to the NNLO x-sections
- qq to WW shapes are taken from NNLO MC + p_TW reweight from NNLL+NNLO
- Measure Wγ* data driven normalization from low di-muon mass region: m_{ll} < 4 GeV

DY → ττ → eμ



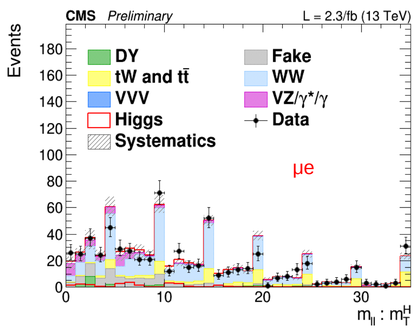
- MC based with normalization from control region low m_T(ll ,MET) region (< 60 GeV)



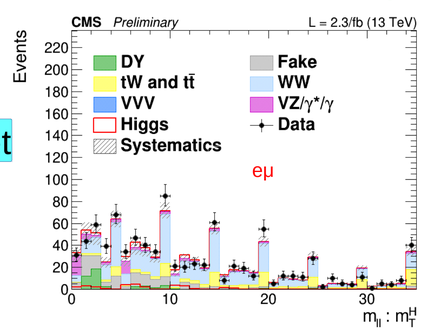
Results & Conclusions

- 2D un-rolled distribution of $m_{ll} : m_T$(ll, MET) : "trains" of m_{ll} in m_T(ll, MET) windows

μe or eμ case based on leading lepton flavor



0 Jet



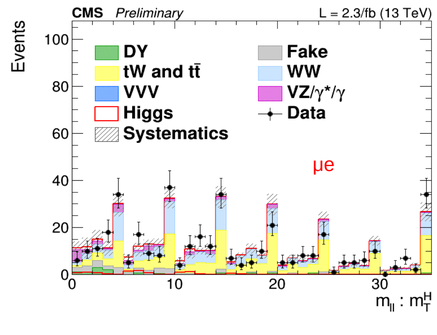
Signal strength

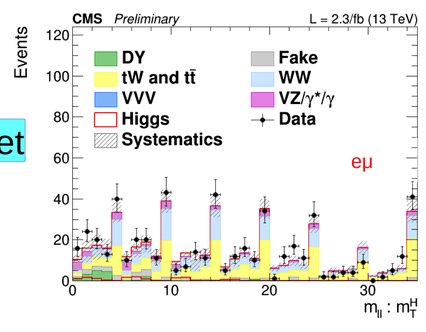
$\sigma / \sigma_{SM} = 0.3 \pm 0.5$

Significance = 0.7 σ

(expected 2.0 σ)

1 Jet





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