Search for the Lepton Flavor Violating Higgs decay $H \rightarrow \tau\mu(e)$

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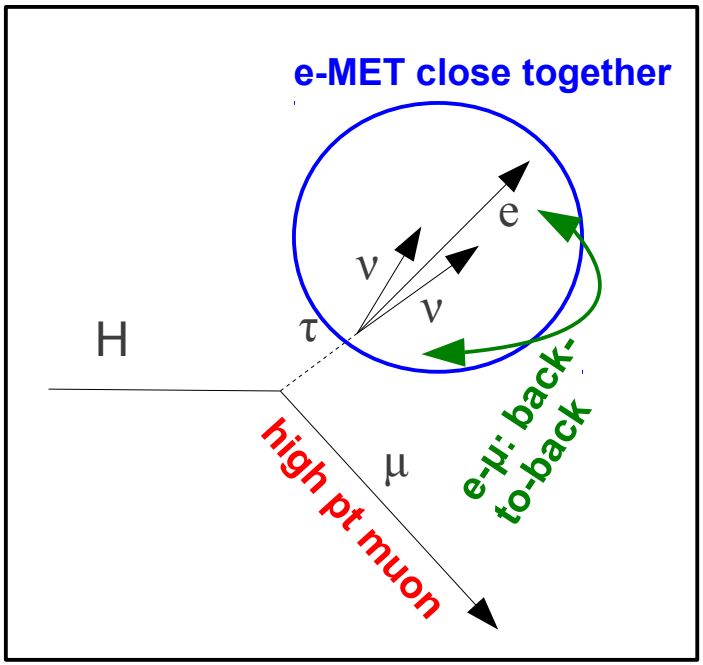
Outline

- Introduction
- Status: Fake Lepton Background Method
- Outlook

Analysis H → τμ(e) → eννμ



- Preliminary studies for LFV Higgs decay in the H → τμ(e) mode
- Baseline Selection:
  - Higgs e-mu trigger
  - 1 tight electron and muon
  - **Gluon-gluon fusion**: no jets in |eta|<4.7
  - **Boosted**: one jets |eta|<4.7
  - **Vector-Boson fusion**: two jets |eta|<4.7

Object Definitions

- PFMuon
  - Pt > 20GeV
  - |eta|<2.1
  - POG ID Tight
  - PFRelIso<0.15
- Electron
  - pt>10GeV
  - |eta|<2.3
  - POG ID Tight (no MVA ID stored yet)
  - PFRelIso<0.15
  - (GSFElectron.Pt()-PFElectron.Pt()))<5GeV
- PFJets
  - pt>30GeV
  - |eta|<4.7
  - ID requirements
- PFMET
  - TypeI - corrected
  - MET x,y shift correction applied

Fake Lepton Background

- **Fake lepton background:**
  - W(lv)+ Jets + fake lepton
  - QCD Multijets + 2 fake leptons
- **Minor background in the various signal regions!**
- **Data-Driven prediction:**
  - Use Same-Sign Events ($e^{\mp}\mu^{\mp}$) to predict Opposite-Sign Events

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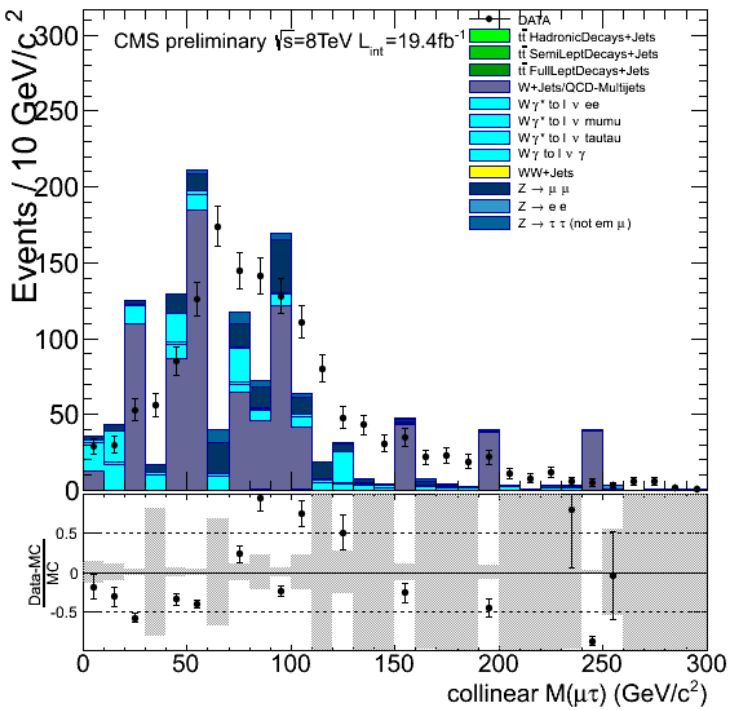
eμ(SS) Distribution

GGF Baseline: eμ(SS)



Note: QCDMultijets(MC) is missing!

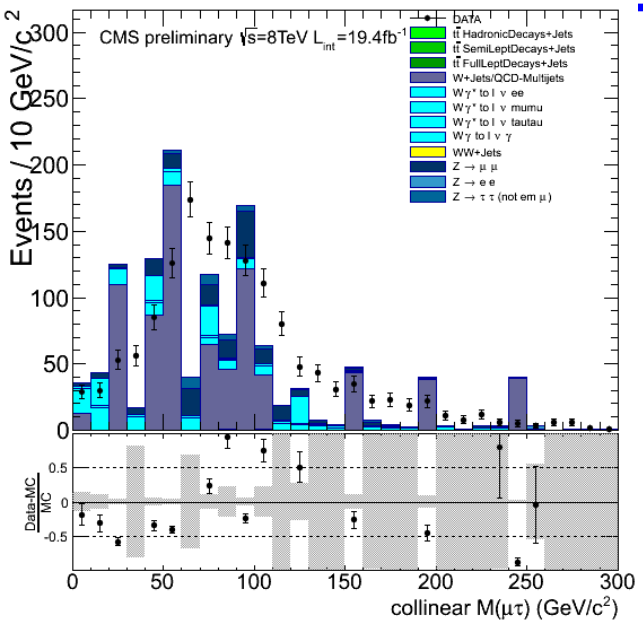
- **Fake lepton background:**
  - W(lν)+ Jets + fake lepton
  - QCD Multijets + 2 fake leptons
- **Additional Contributions:**
  - FSR/ISR Photon+Conversion (internal+external)
  - Z→μμ→ μ μγ

Reconstructed as an electron!

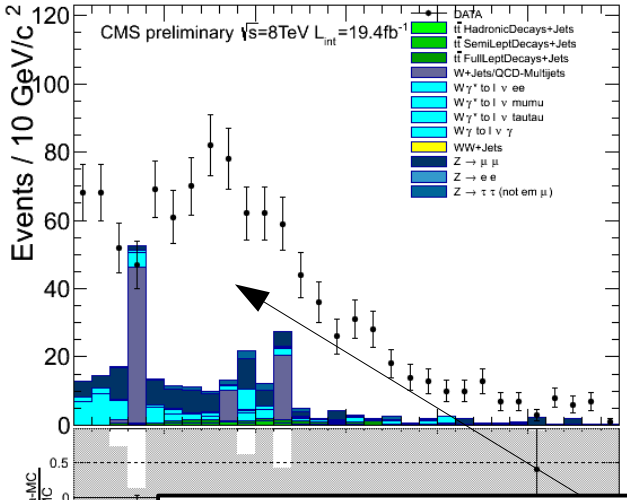
Charge (in-)dependent: rate is roughly 40% reduced in same-sign events (MC)!

eμ(SS) Distribution

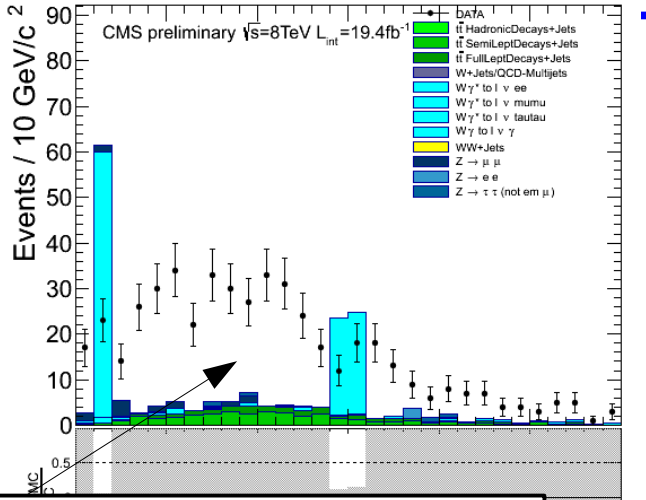
GGF Baseline: eμ(SS)



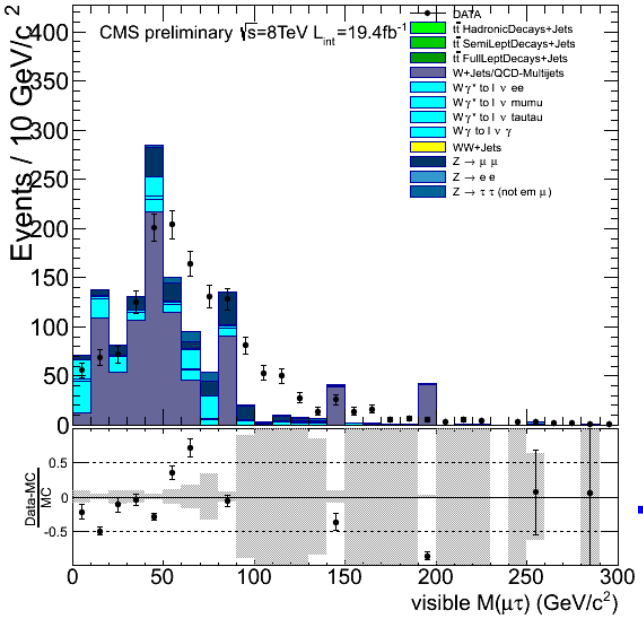
Boosted Baseline: eμ(SS)

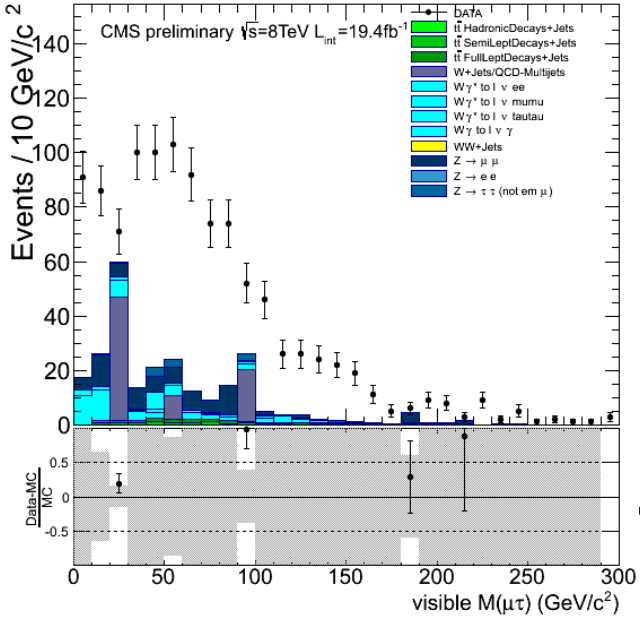


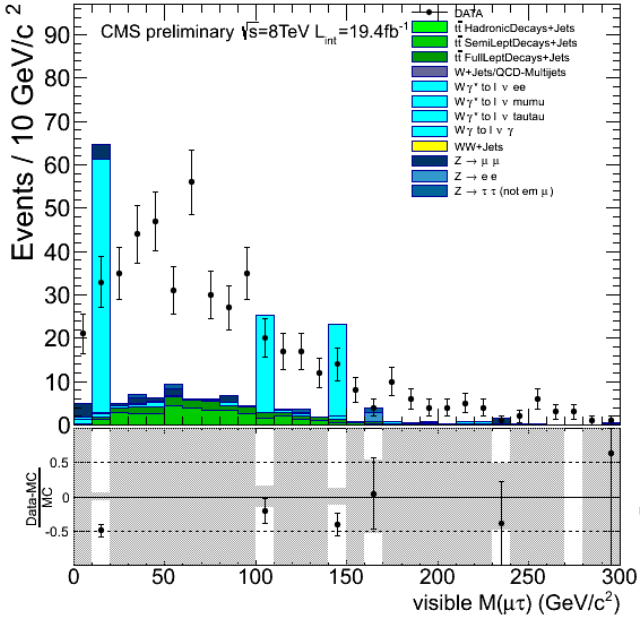
VBF Baseline: eμ(SS)



Big contribution missing: QCDMultijets only?
MCs missing!

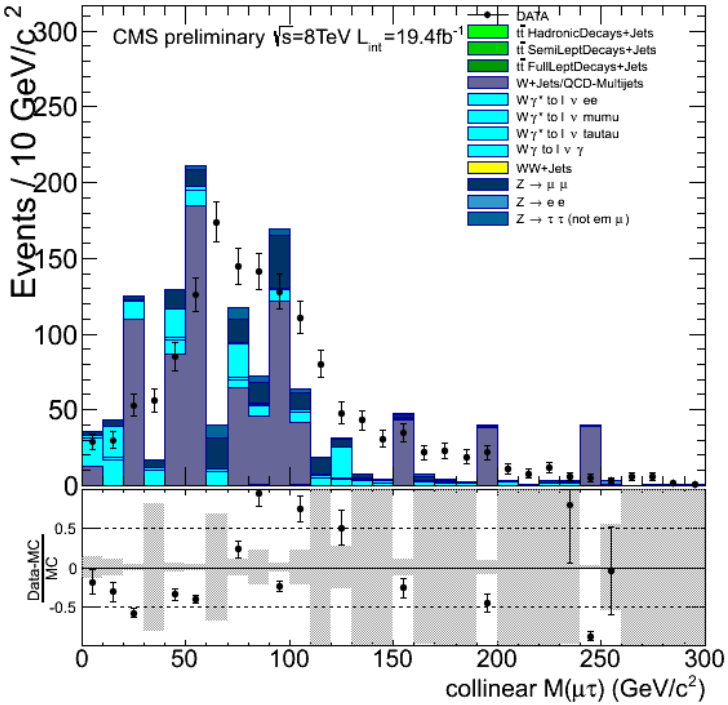




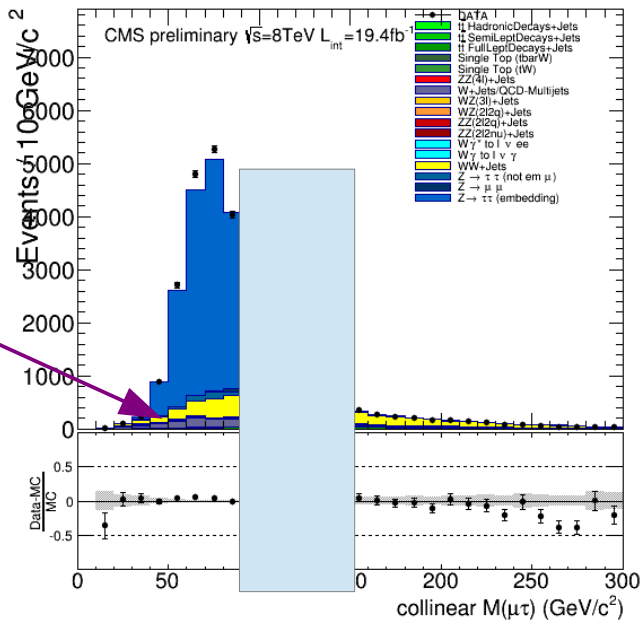


eμ(OS) Distribution

GGF Baseline: eμ(SS)



GGF Baseline: eμ(OS)

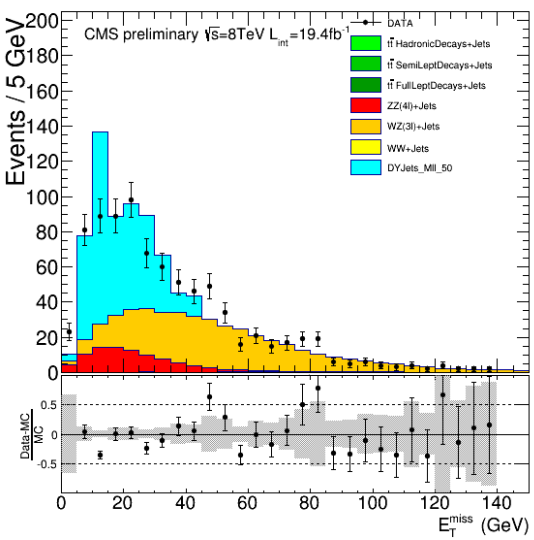


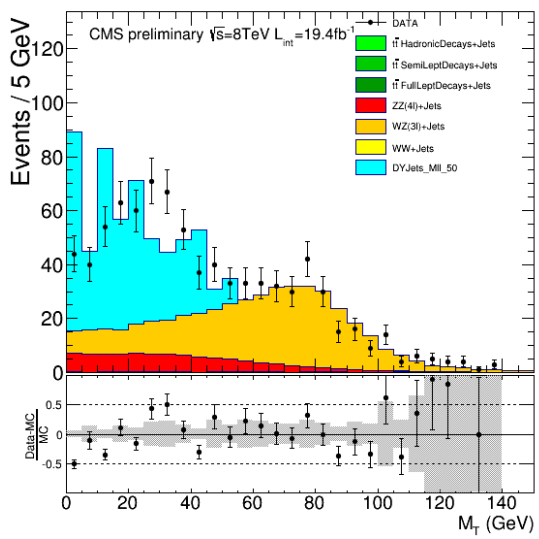
eμ(SS): loose electron

- Fake Leptons have only a vary small contribution to the signal region! (shown only baseline selection)
  - Problem: eμ(SS) has also very low statistics in the signal regions!
  - W(e,mu)+γ^* is reduced in SS events!
  - ➔ Loose electron(muon) (loose isolation) in order to enhance the statistics! → fake-lepton background
  - e(mu) + γ events to estimated W(e,mu)+γ^*

eμ(SS): loose electron

- Measure **tight-to-loose** ratio for fake-electrons in data
  - Here Z → μμ + fake electron
  - M()=MZ+/-15GeV + loose electron
  - If tight-electron → high WZ contribution

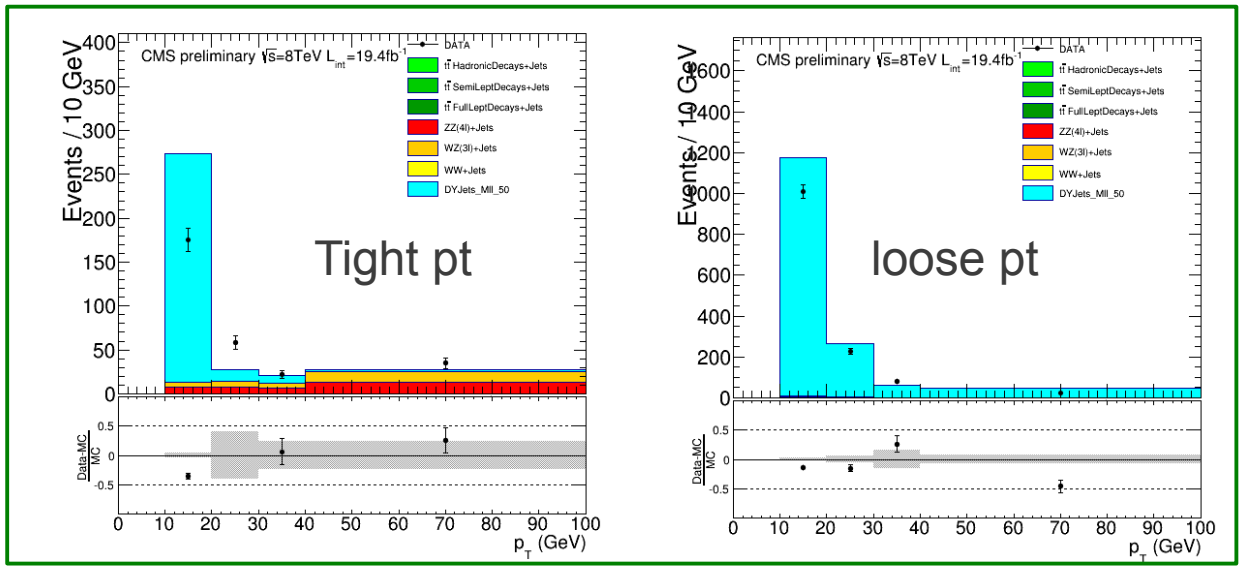


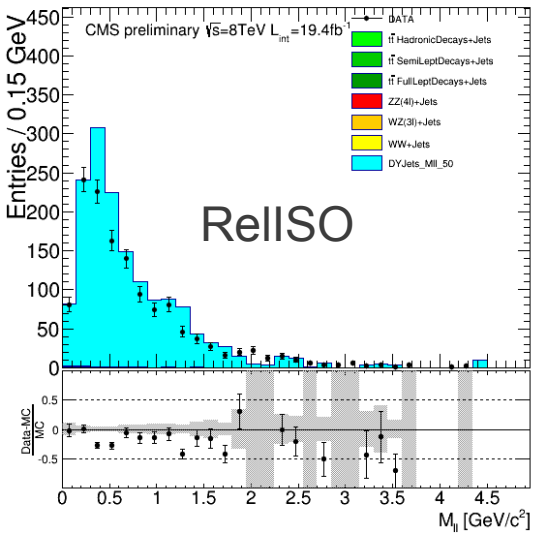


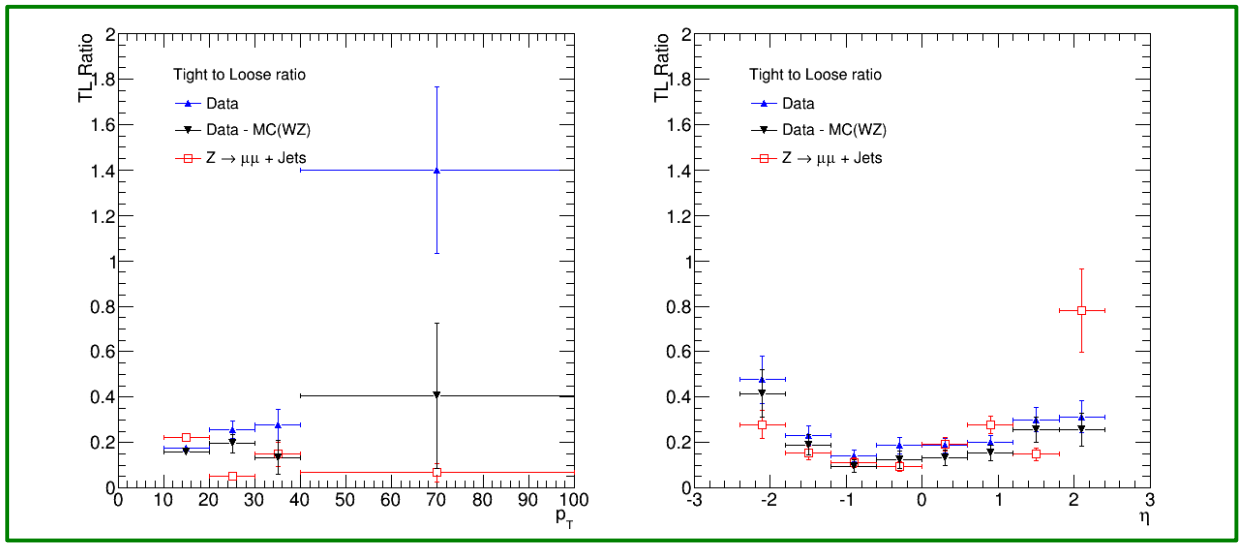
WZ can be suppressed by:

MT<30 && MET<40

eμ(SS): loose electron





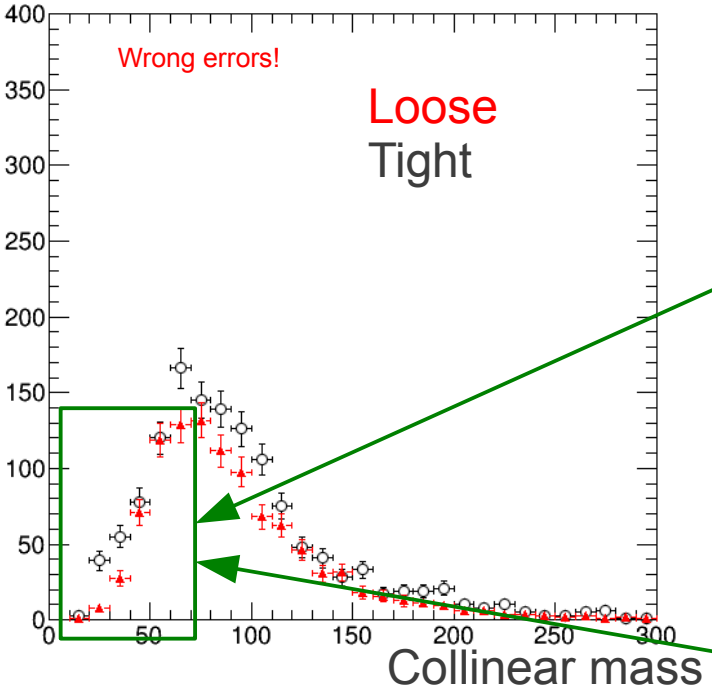


- **Tight-to-Loose ratio to be measured as function of (pt,eta)**

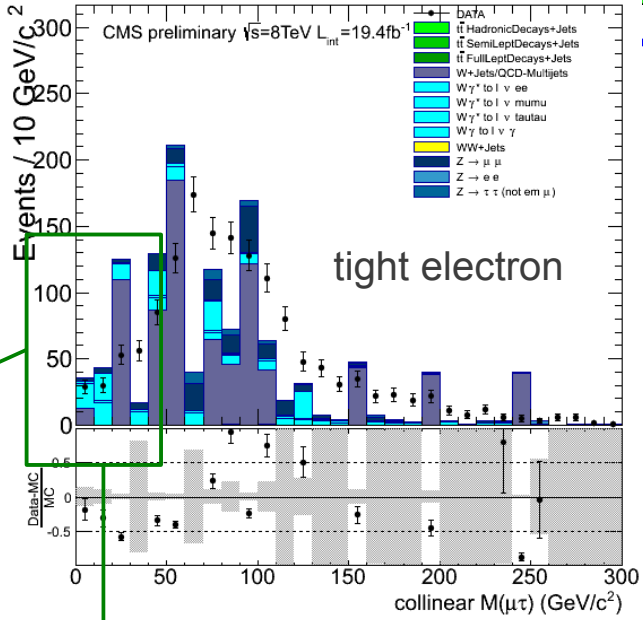
Plan: go to QCD and measure TL ratios there

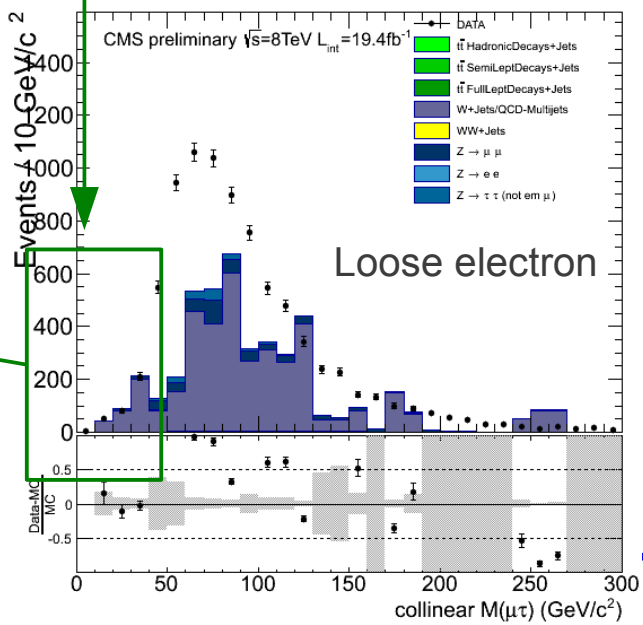
eμ(SS): loose electron

GGF Baseline: eμ(SS)
Loose(x TLRatio(pt)) vs tight



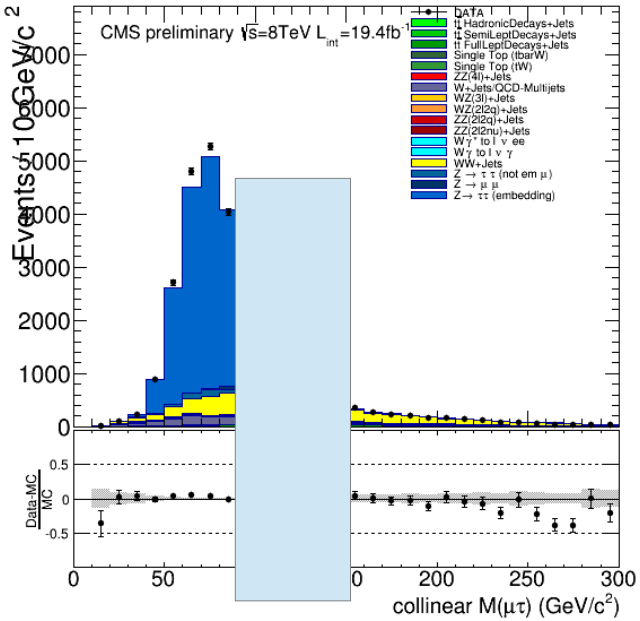
No FSR/ISR contribution in loose electron sideband!



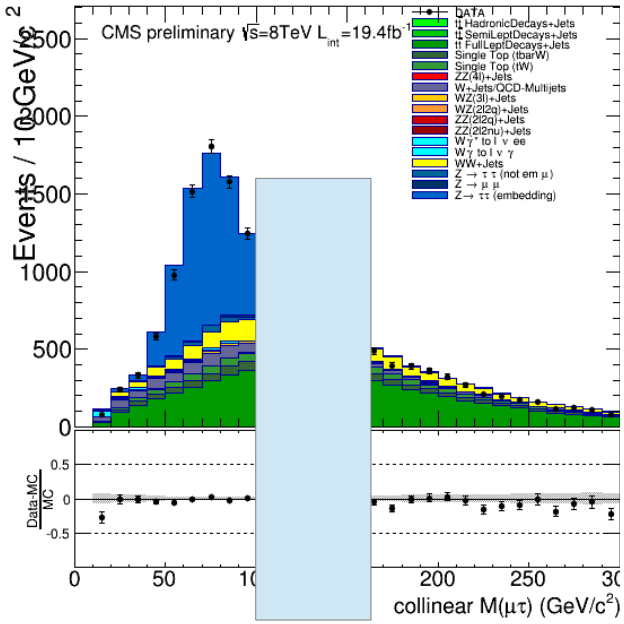


Status Overview

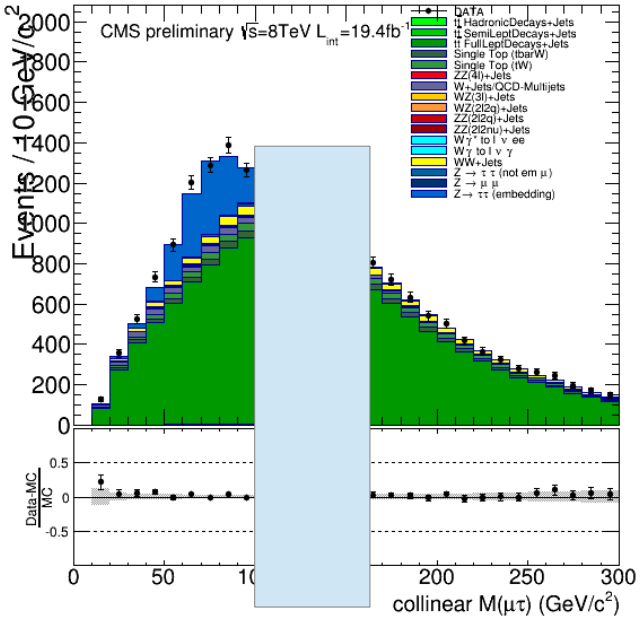
GGF



Boosted



VBF



Signal Categories: Summary

GGF Category:

- Baseline+
- Njets=0
- $p_T(\mu) > 40$ GeV
- $\Delta\Phi(e,MET) < 0.5$
- $\Delta\Phi(e,\mu) > 2.7$

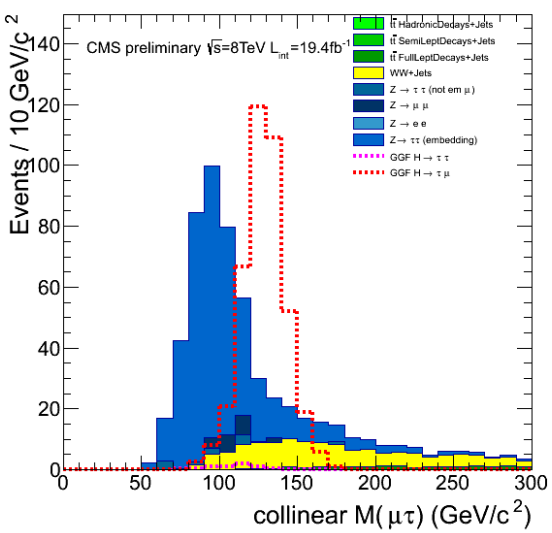
Boosted Category:

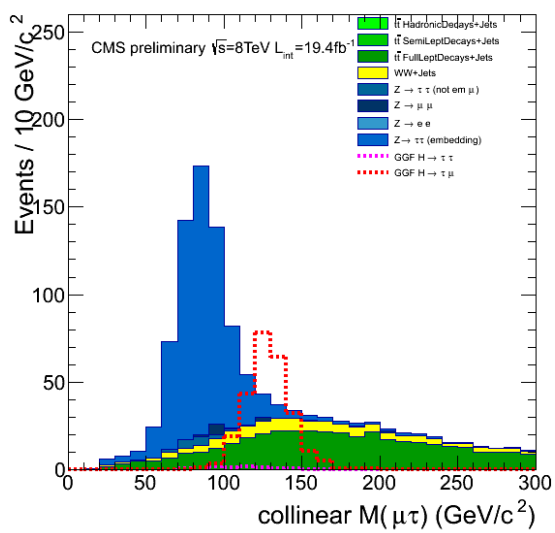
- Baseline+
- Njets==1
- $p_T(\mu) > 30$ GeV
- $\Delta\Phi(e,MET) < 0.3$

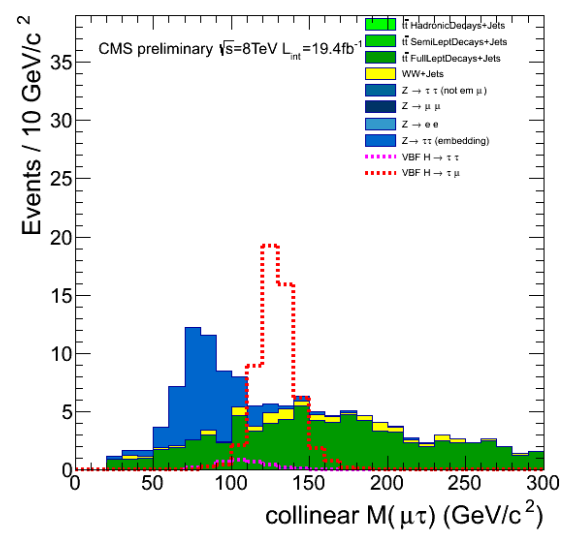
To be optimized!

VBF Category:

- Baseline+
- Njets=2
- Mjj > 300 GeV
- $\Delta\eta(jj) > 3$
- $\eta*\eta<0$
- $p_T(\mu) > 25$ GeV
- $\Delta\Phi(e,MET) < 0.3$

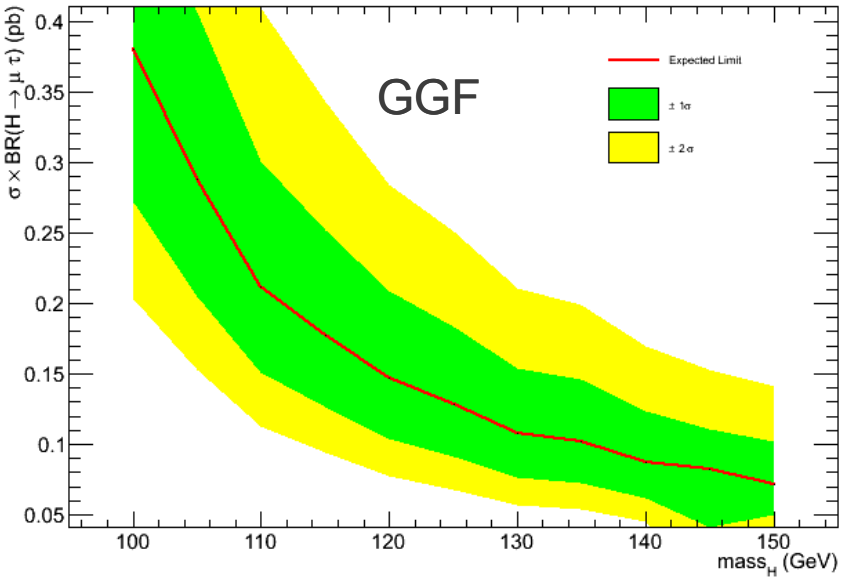


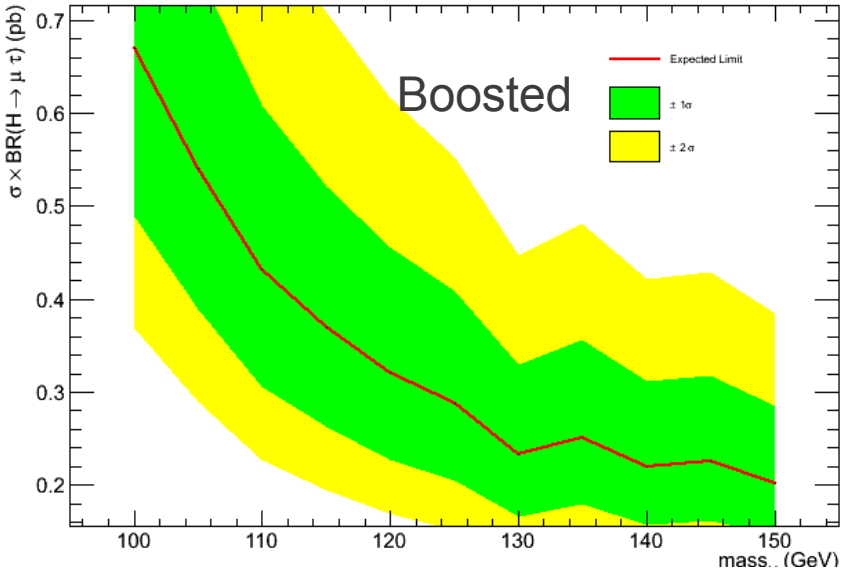




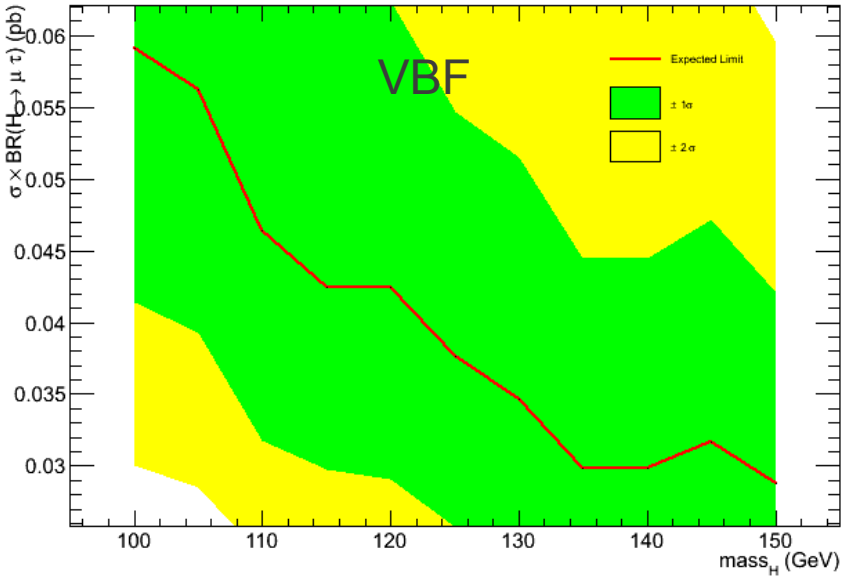
Signal: σ(SM H) x BR(H→μτ = 10%)

Expected limits





- Expected limit on branching fraction assuming SM cross section ~1%
- **Very preliminary**: basically just machinery testing
- But: most sensetive = GGF category
  - Boosted + VBF to be optimzed



Outlook

Next Steps:

- Add QCDMC → understand SS events
- Fake lepton background → go to loose isolated electrons
- And and and.....