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Search for exotic and rare Higgs boson decays at CMS

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On behalf of the CMS Collaboration

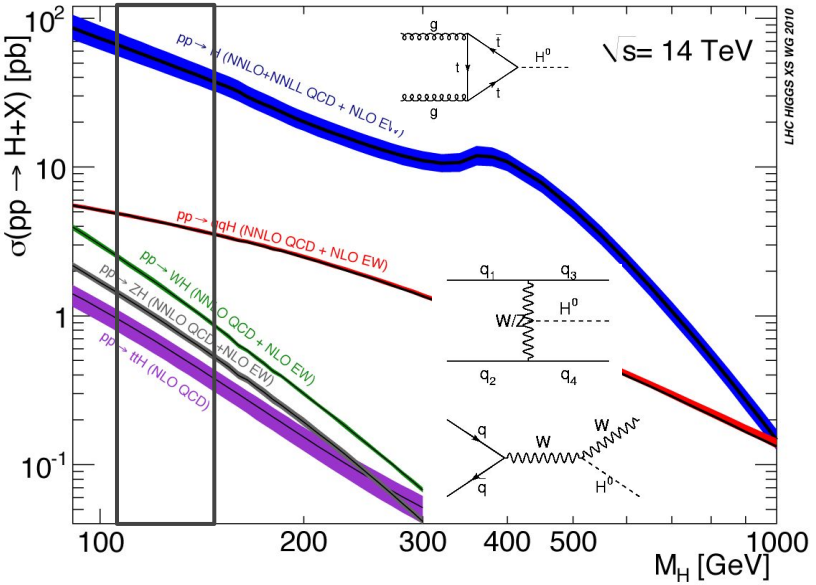
University of Hamburg

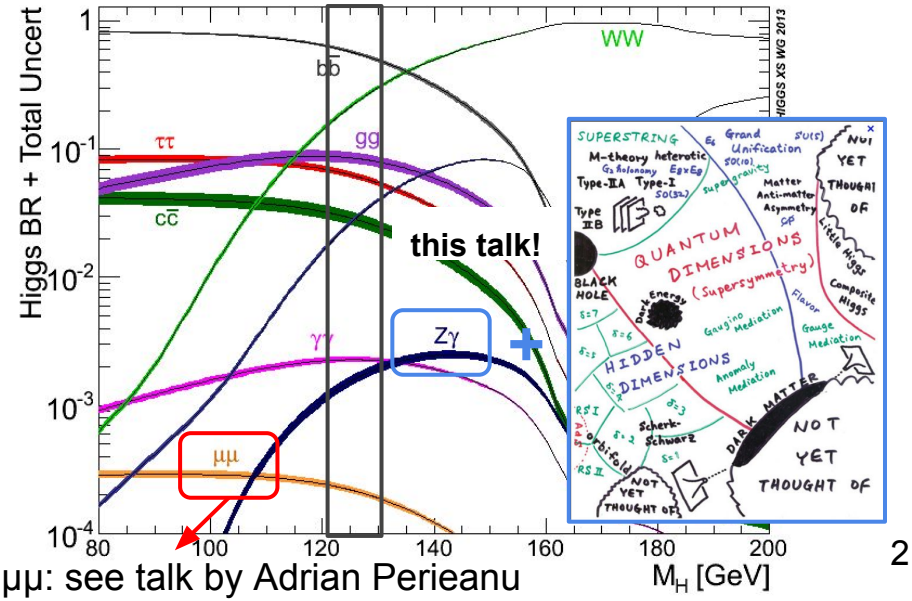
DIS 2016, Hamburg

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Outline

- SM: H→Zγ
- SM: H→γ*γ
- Higgs to Invisible
- Higgs to Invisible+γ
- LFV Higgs
  - H→μτ
  - H→eτ
  - H→eμ
- Conclusion

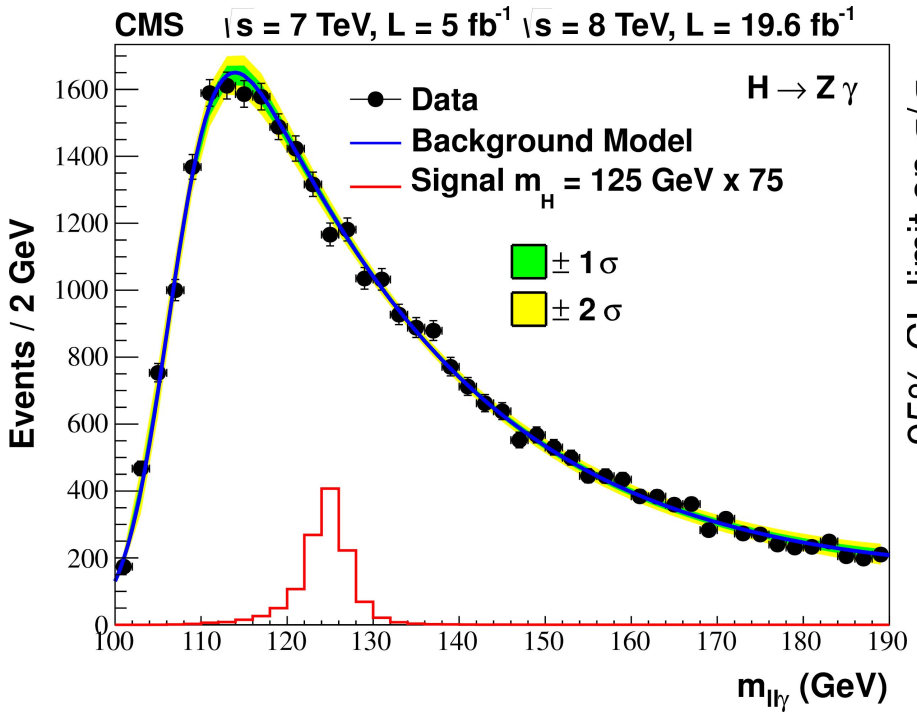


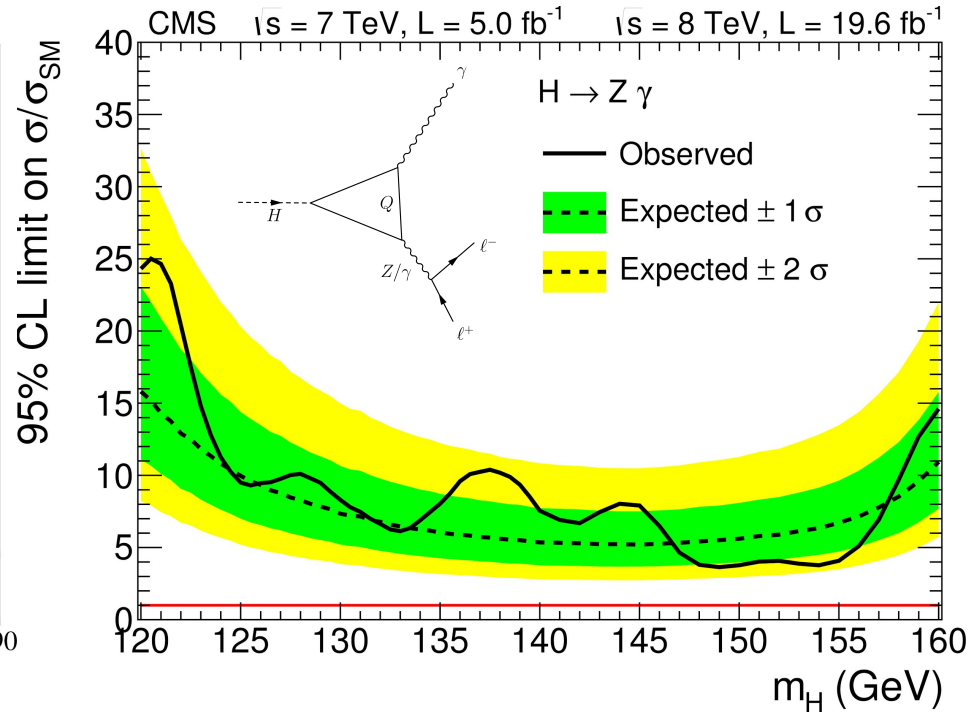


H→μμ: see talk by Adrian Perieanu

Phys. Lett. B 726 (2013) 587-609

SM H→Zγ

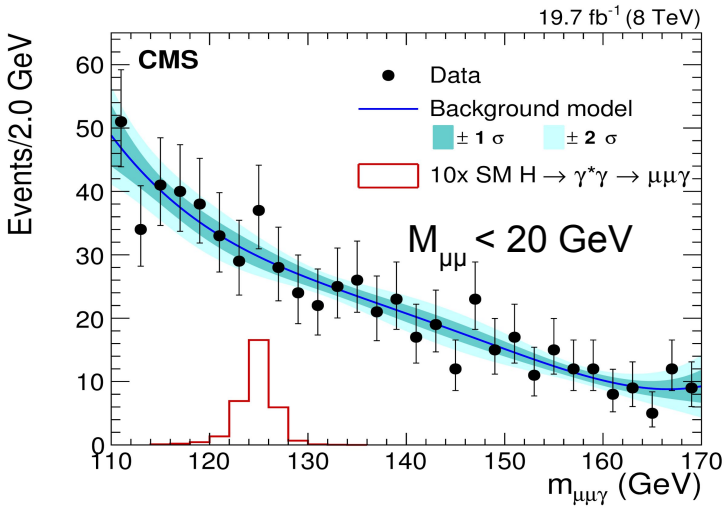


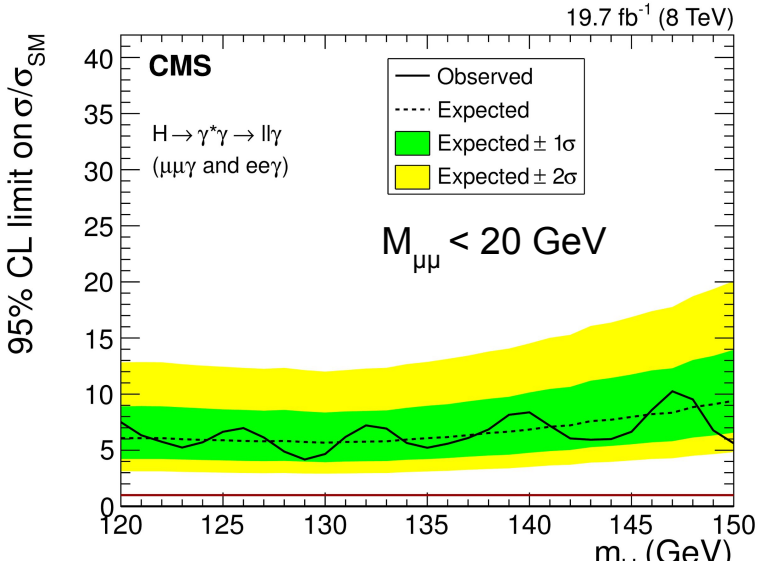


- Two leptons and one photon in the final state: relatively clean events!
- Very low expectation: split in categories to enhance S/B and mass resolution
- No significant excess over background predictions has been observed
- **Limits on σ/σ_{SM} (125GeV) =9.5 (10 exp.)!**

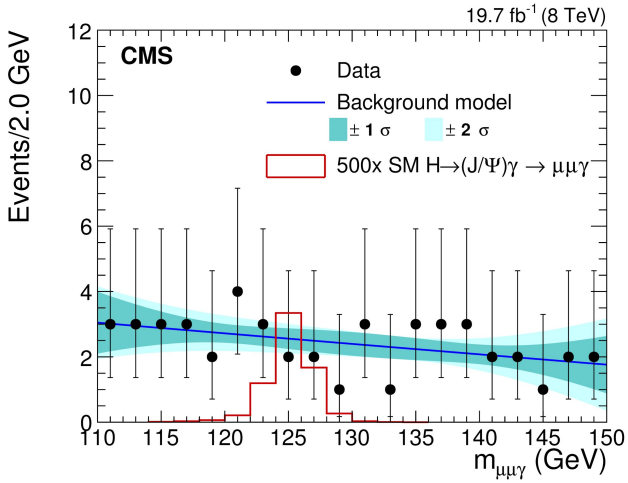
Phys. Lett. B 753 (2016) 341

SM H→γ*γ →llγ (low dilepton mass)



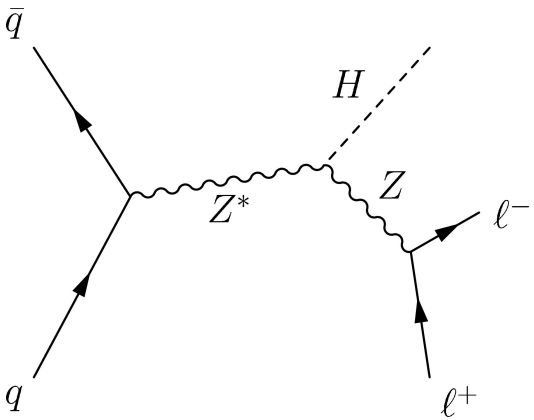


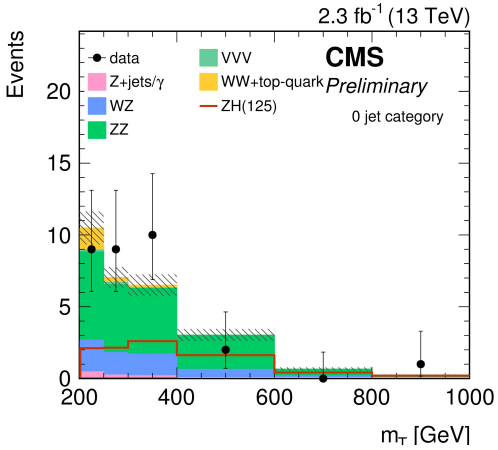
- Similar to previous analysis: two leptons and one photon, but low mass dileptons, hence leptons are collimated.
- No significant excess over background predictions has been observed.
- **Limits on σ/σ_{SM} (125GeV) =6.7 (5.9 exp.)!**
- Dilepton within J/ψ mass window: Limit on B(H→ (J/ψ) γ) < 1.5^{-3}

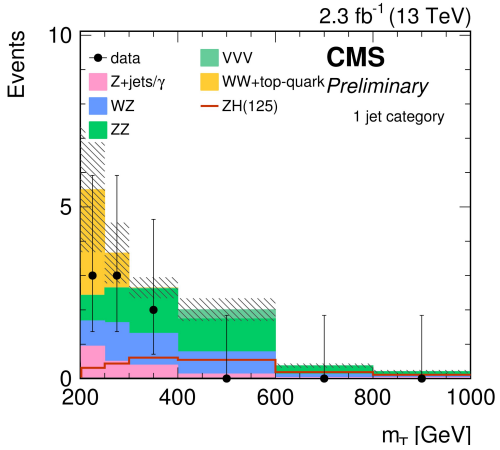


CMS-PAS-HIG-16-008

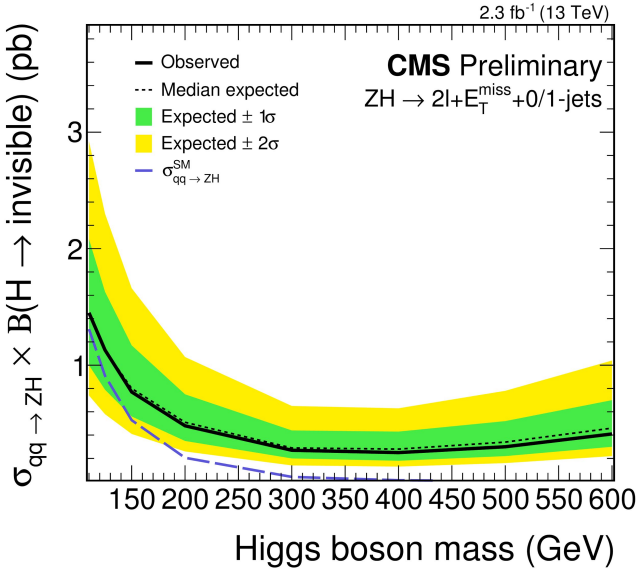
H→Invisible: ZH @ 13 TeV





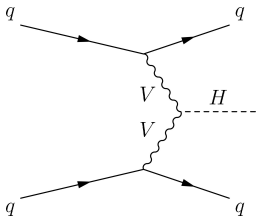


- SM H→Z*Z→4ν is very rare (BR~0.1%)
- Many contributions from BSM models!
- ZH production mode: low production cross section but lower backgrounds as well
- Dilepton system within Z-Boson mass window
- Analysis update with 2.3fb^{-1} (13TeV) public!
- No significant excess has been observed...

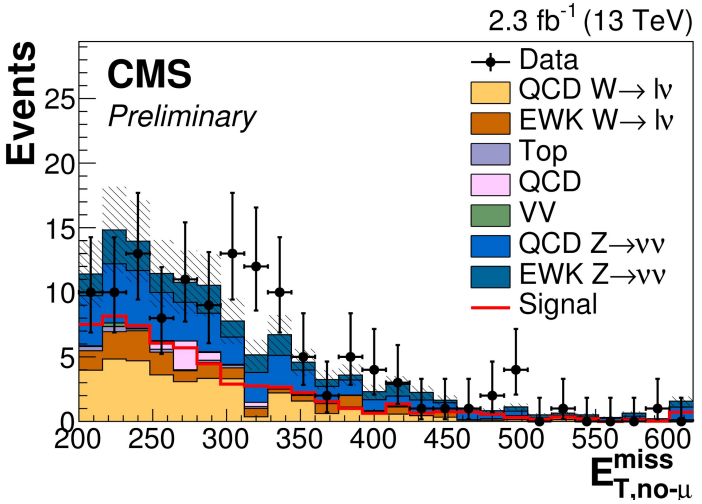


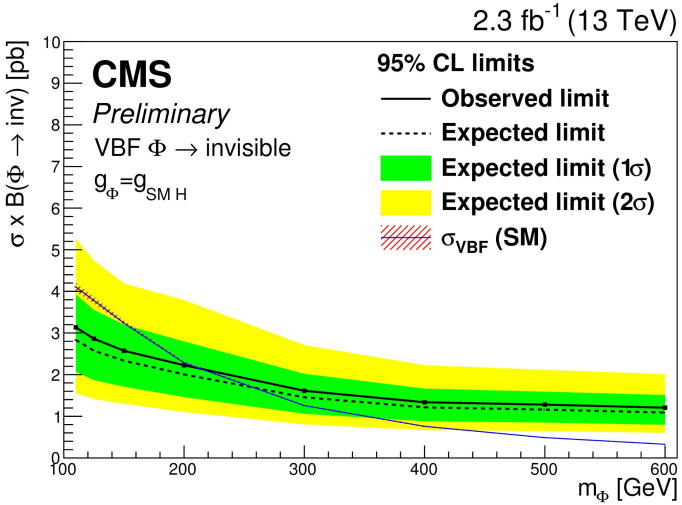
CMS-PAS-HIG-16-009

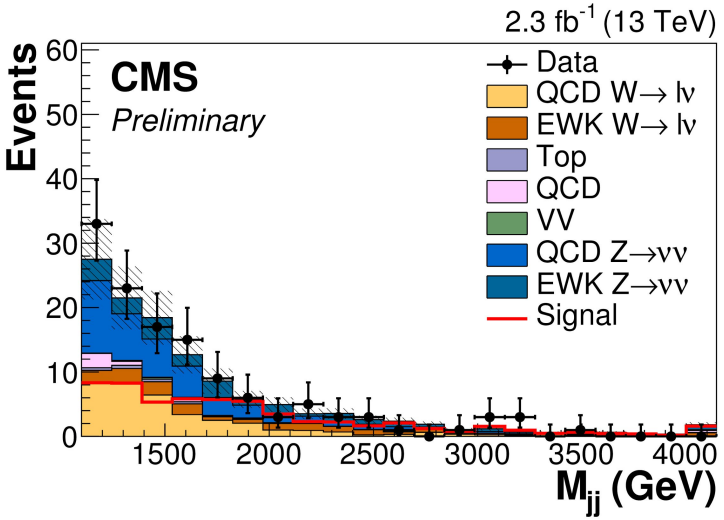
H→Invisible: VBF @ 13 TeV



- σ(pp→VBF H)> σ(pp→ZH): but more backgrounds (Z→νν, W+Jets, QCD)
- VBF selection: large $\Delta\eta_{jj}$ and m_{jj}
- Analysis update with 2.3fb^{-1} (13TeV) public!
- No significant excess has been observed...



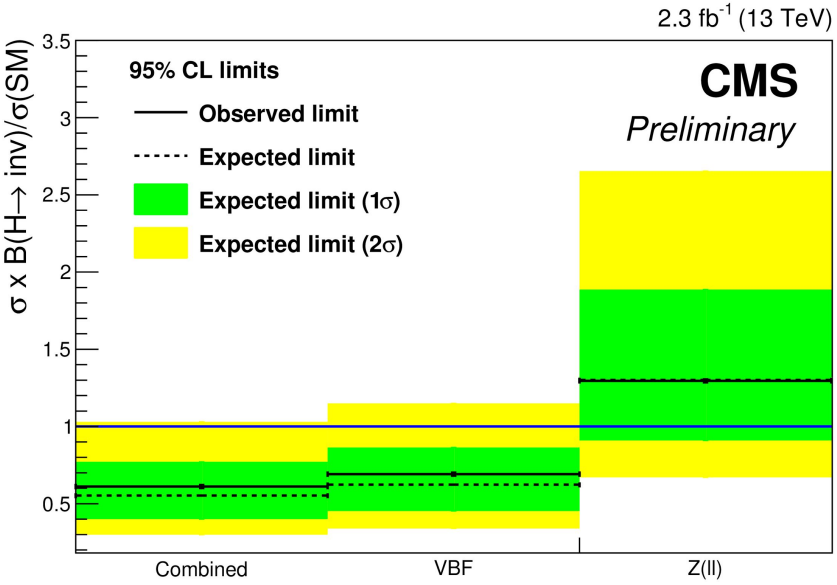




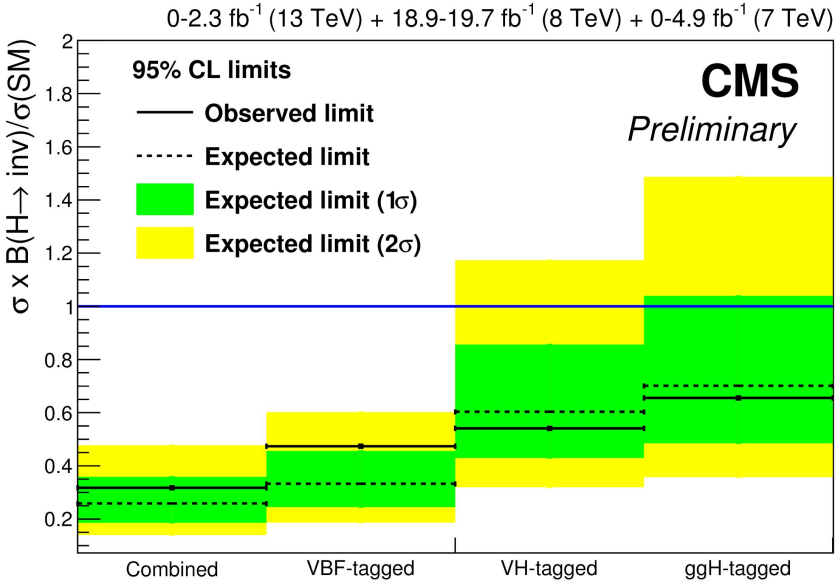
CMS-PAS-HIG-16-009

H→Invisible: Combination

13 TeV only combination (Z(ll)H+VBF H)



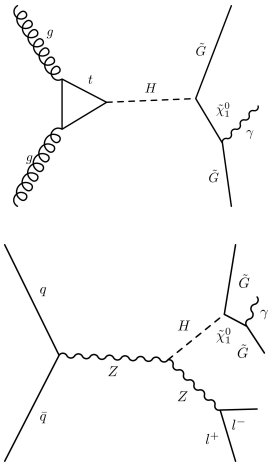
8+13 TeV combination!



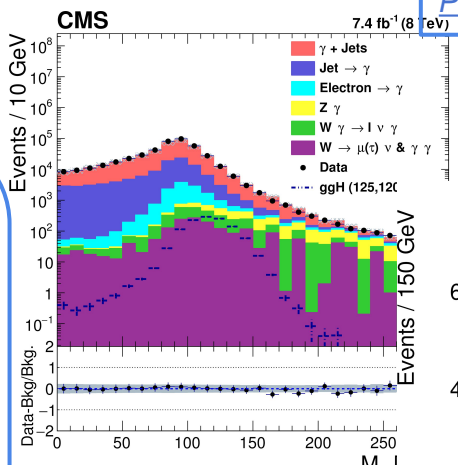
Updated Limit on BR(H→Invisible)= 32% (26% exp.)!

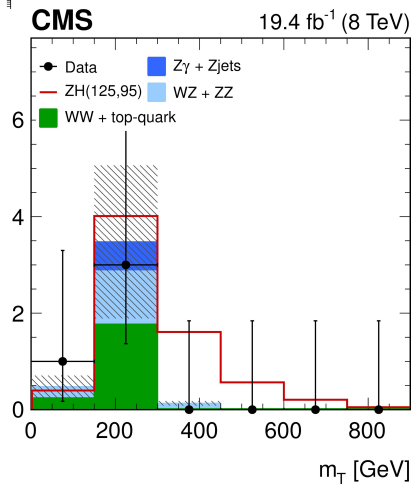
Phys. Lett. B 753 (2016) 363

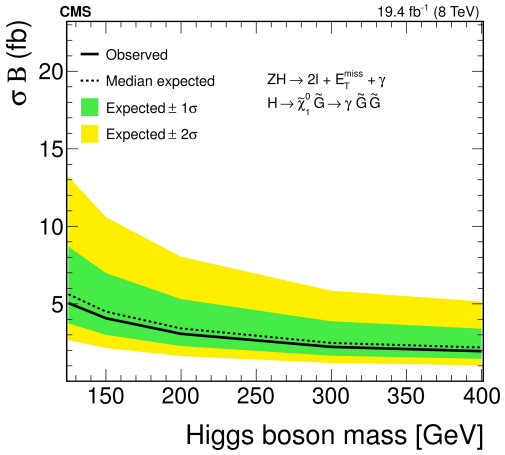
H→Invisible+γ

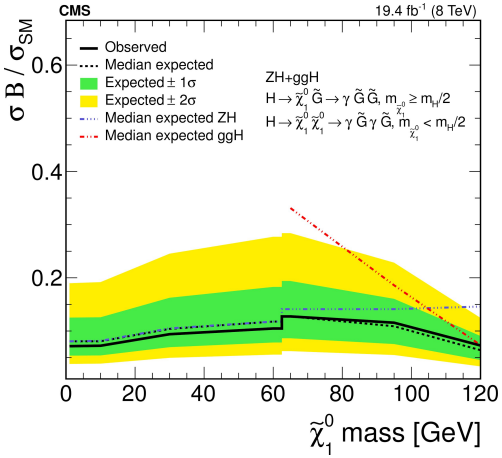


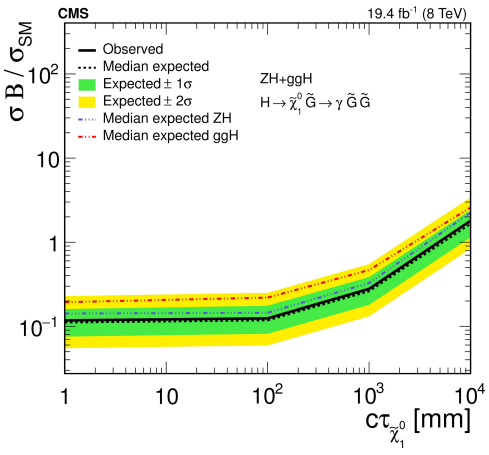
- ggH and ZH production modes considered
- ggH: model dependent (SUSY) and quasi-model independent strategy based on the jet multiplicity
- ZH: dilepton system within Z mass window, a photon and large missing energy
- Again: no significant excess over the background predictions has been observed





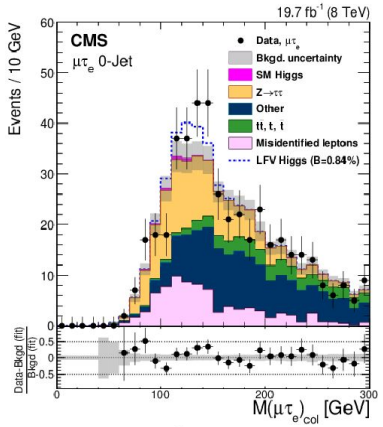


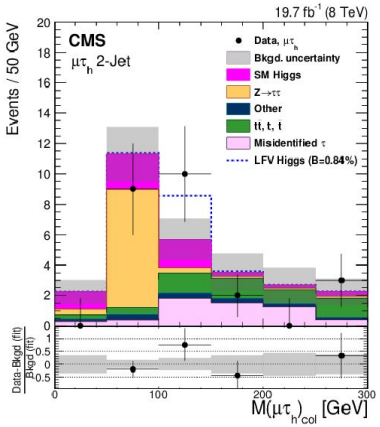


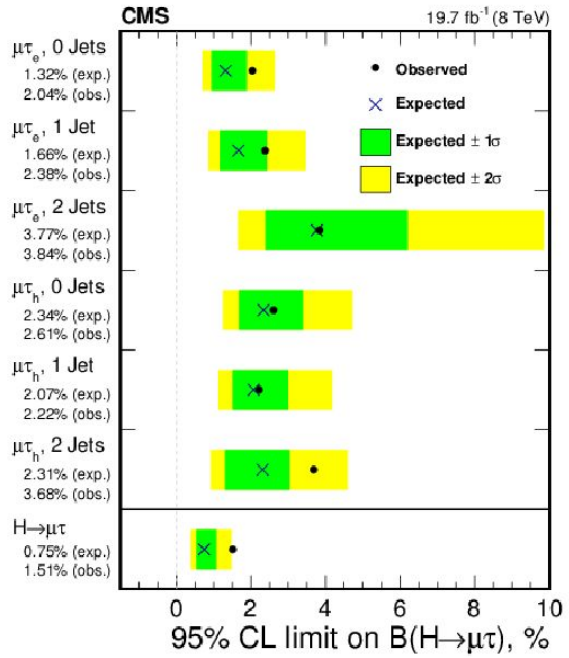


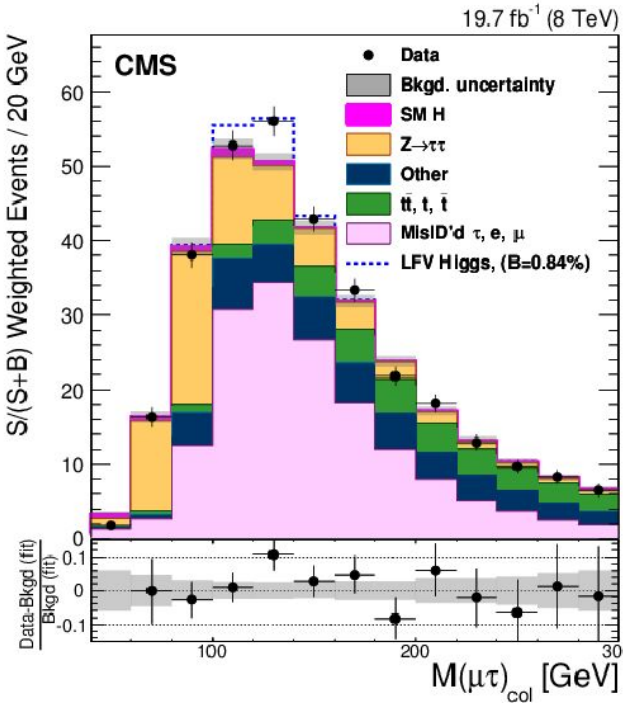
LFV H→μτ

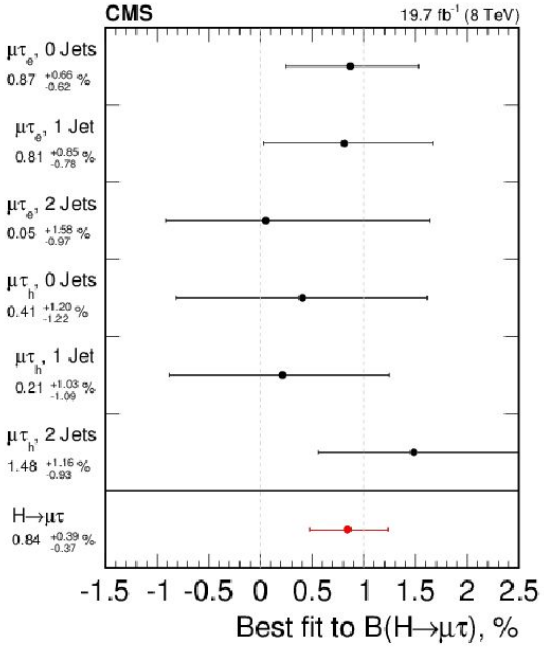
- 2 channels: leptonic tau (e) and hadronic tau decays
- GGF and VBF production considered: 0,1 and 2-Jet categories
- Kinematic cuts to enhance S/B ratio











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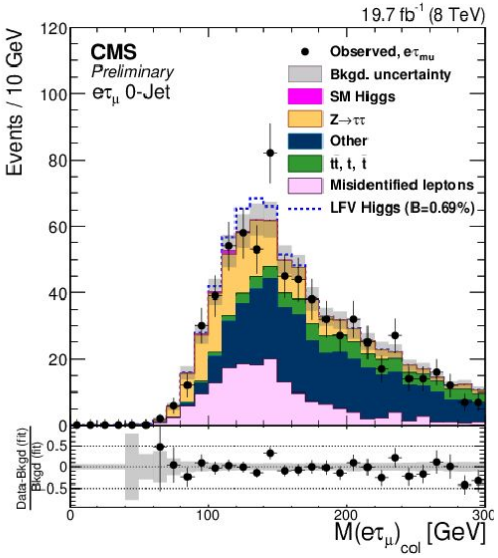
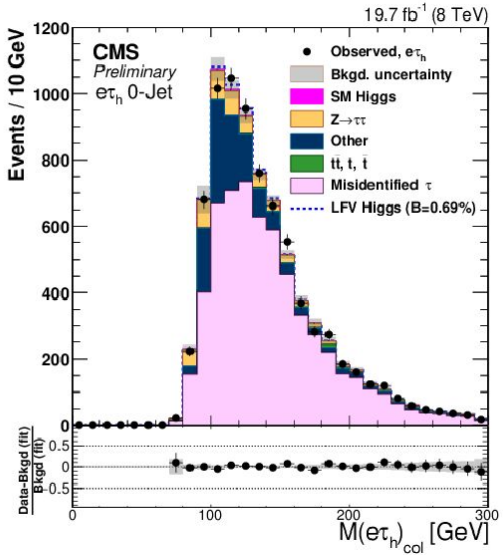
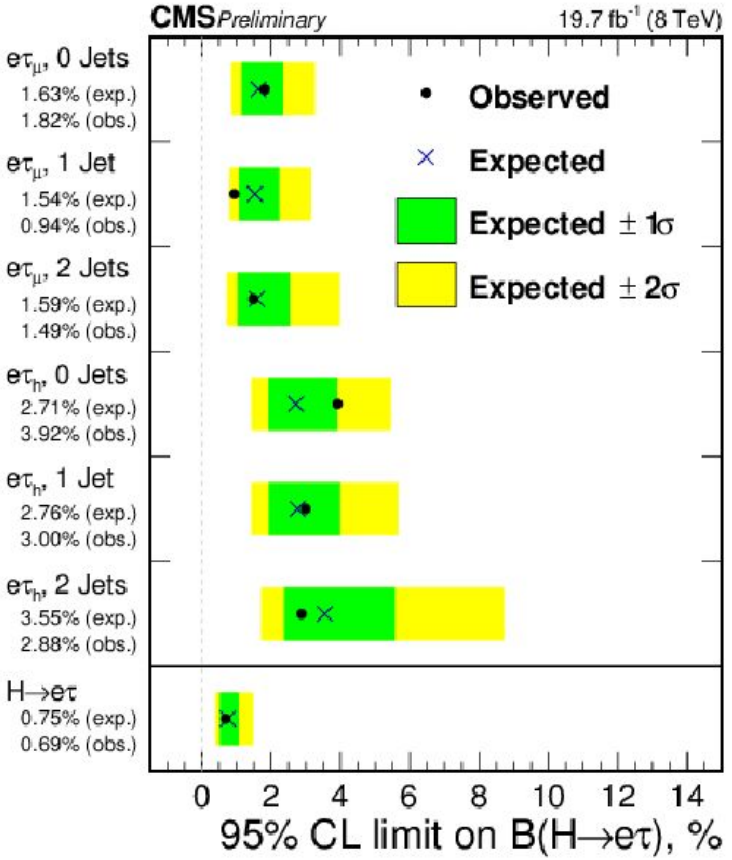
CMS-PAS-HIG-14-040

LFV H→eτ

- Analogous to H→μτ analysis:
- 2 channels: leptonic (μ) and hadronic tau decays
- GGF and VBF production channels: 0, 1 and 2-Jet categories







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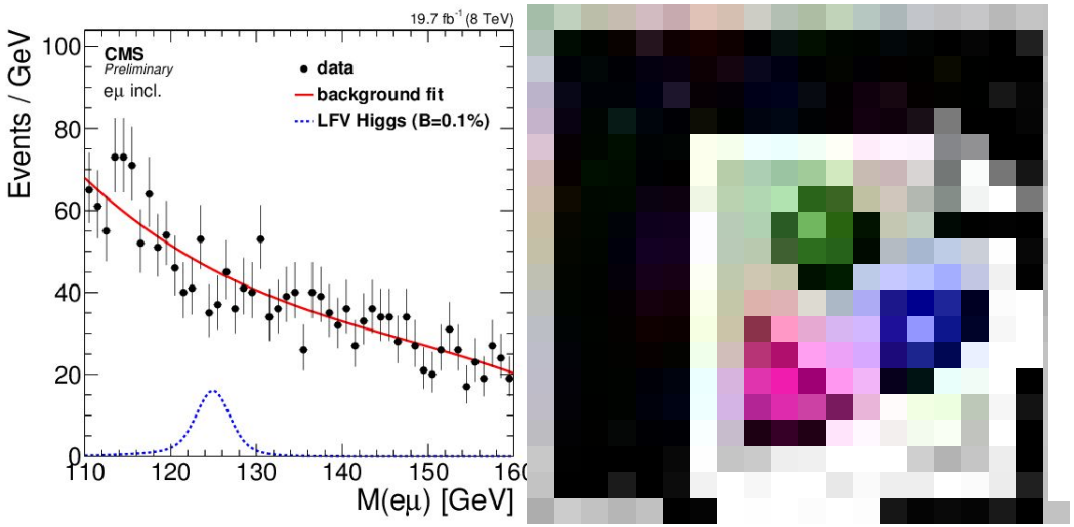
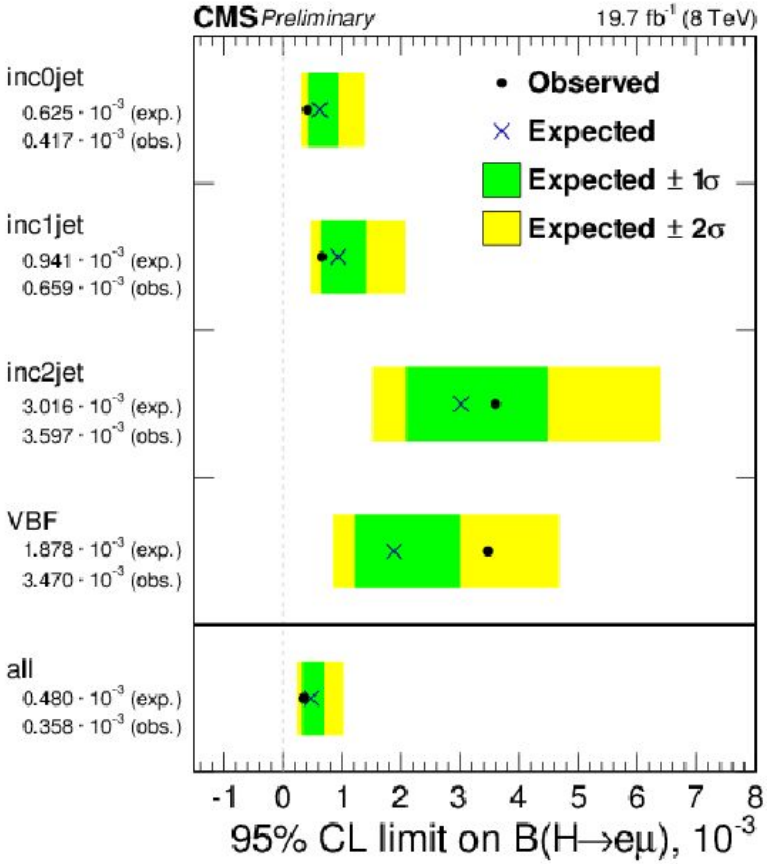
LFV H→eμ

CMS-PAS-HIG-14-040

- Dilepton trigger (e,μ)
- GGF and VBF production: 0,1 and 2 Jet category
- Split in Barrel and Endcap region (resolution)
- Low MET in the events is required
- Background: 'simple' fit of the dilepton invariant mass distribution $m_{e\mu}$=[110,160]





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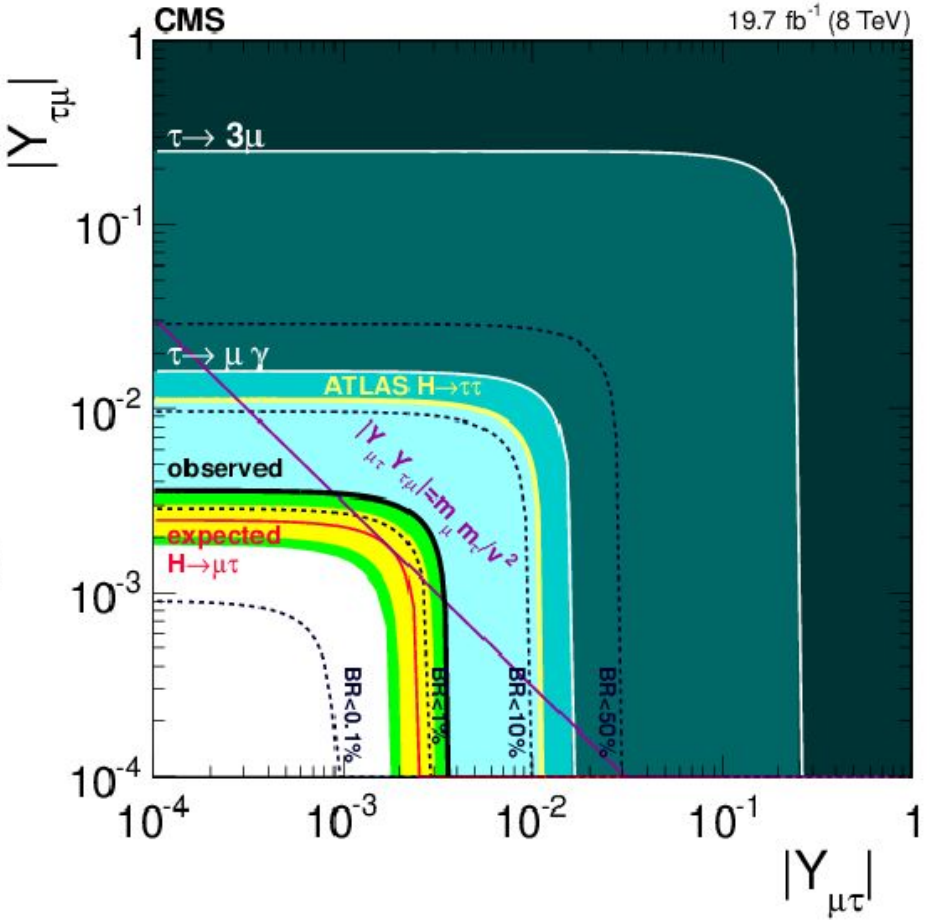
H→μτ: interpretation

- Limit on BR can be reinterpreted as a limit on the corresponding flavor violating yukawa coupling

$$BR\left(h \to l^{\alpha} l^{\beta}\right) = \frac{\Gamma\left(h \to l^{\alpha} l^{\beta}\right)}{\Gamma\left(h \to l^{\alpha} l^{\beta}\right) + \Gamma_{SM}}$$

$$l^{\alpha,\beta} = e, \mu, \tau \; with \; l^{\alpha} \neq l^{\beta}$$

$$\Gamma\left(h \to l^{\alpha} l^{\beta}\right) = \frac{m_h}{8\pi}\left(\left|Y_{l^{\alpha} l^{\beta}}\right|^2 + \left|Y_{l^{\beta} l^{\alpha}}\right|^2\right)$$



Assumptions:

- SM Higgs decay width Γ_{SM}=4 MeV
- At most one of non-standard decay mode of the higgs is significant compared to SM decay width

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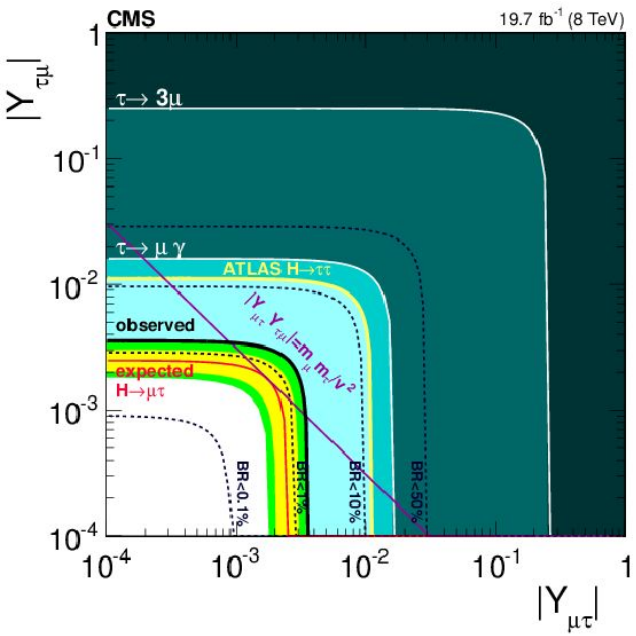
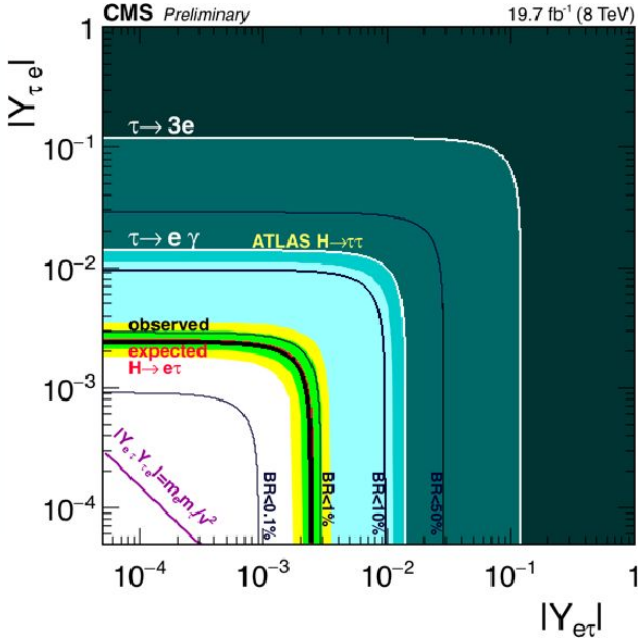
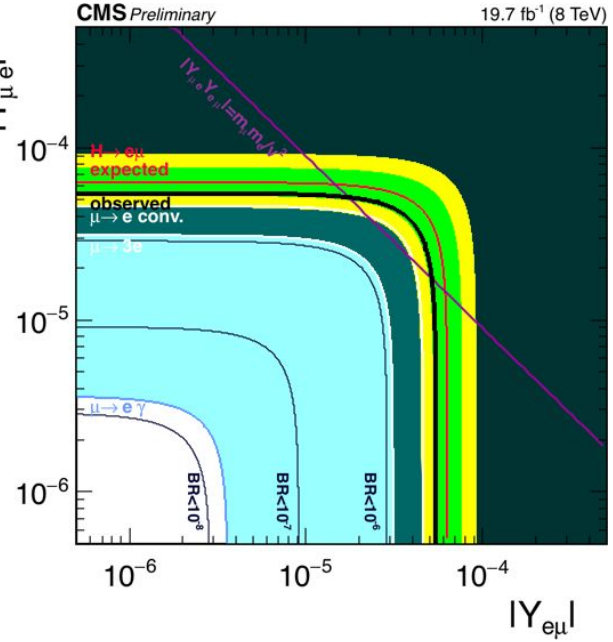
LFV Higgs @ 8TeV: Summary







Update with 2.3fb^{-1} (13TeV) close to be public!

Conclusion

- Extensive search program for rare and exotic Higgs production in Run-I
- First 13 TeV results appeared, but most of the searches need more Data: end of the year will be exciting with many updated and new results!