מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

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Asymmetric Lepton Flavor Violating Higgs Decays

Shikma Bressler, AD, Aielet Efrati arXiv:1405.4545

Asymmetric Lepton Flavor Violating Higgs Decays

Neutrinos oscillate. **Lepton Flavor is broken in Nature.**

$$U(1)_e \times U(1)_\mu \times U(1)_\tau$$

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Existing indirect constrains on Yukawa couplings:

Eff. couplings	Bound	Constraint
$\lvert c_{e\mu}\rvert^2,\ \lvert c_{\mu e}\rvert^2$	1×10^{-12}	$\mathcal{B}(\mu \to e\gamma) < 5.7 \times 10^{-13}$
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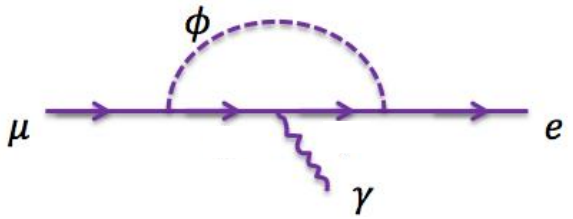
$Y_{e\mu}$ **is extremely small.**



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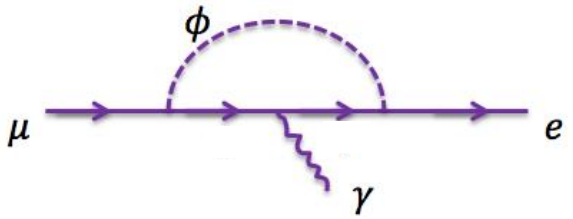

On the other hand, $Y_{\tau\mu}$, $Y_{\tau e}$ are very weakly constrained:

$$Br(h \to \tau\mu),\ Br(h \to \tau e) \leq 20\% \text{ !}$$

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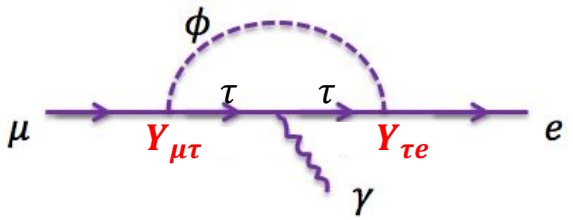

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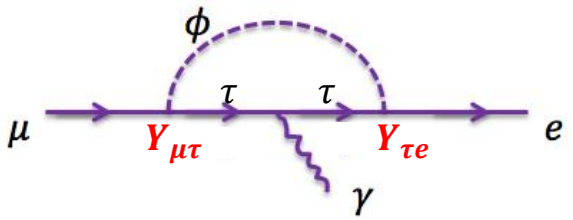

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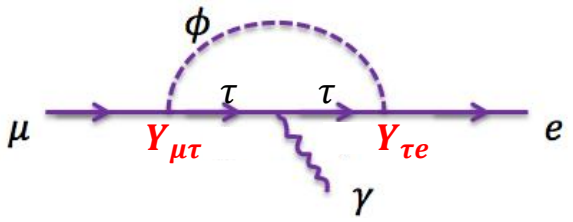

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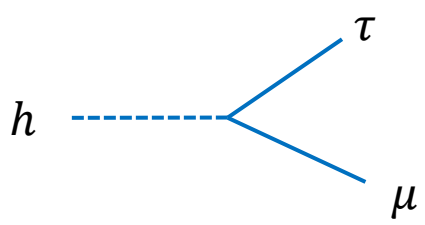
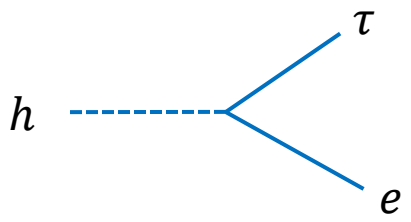
=> **EITHER** $h \to \tau\mu$ exists **OR** $h \to \tau e$ exists, but not both!

(or, neither exists in observables rates… shhhh)

We developed a method to search for both these decays simultaneously, using two mutually exclusive data samples in the same analysis and extracting a BG estimation directly from them (no MC involved!)

Asymmetric Lepton Flavor Violating Higgs Decays





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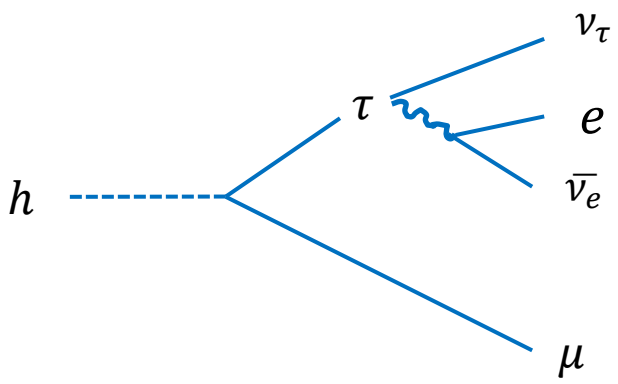

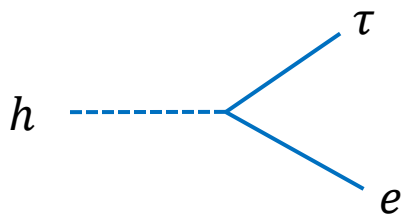

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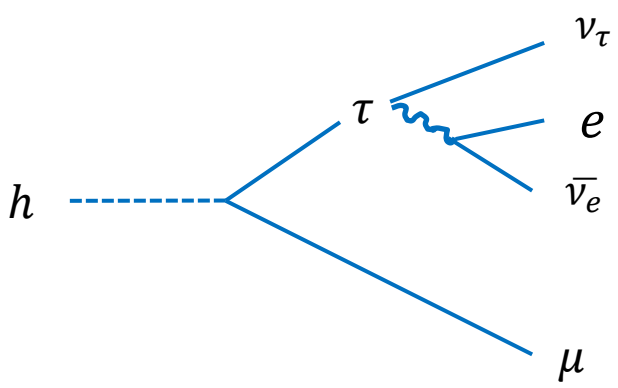

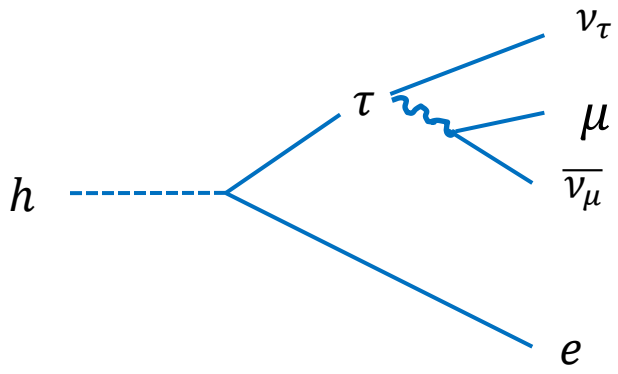

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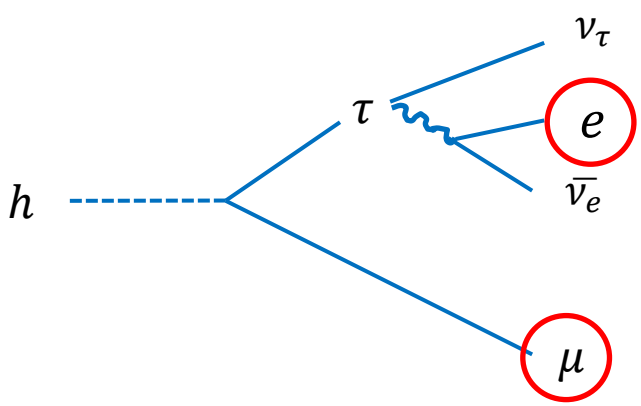

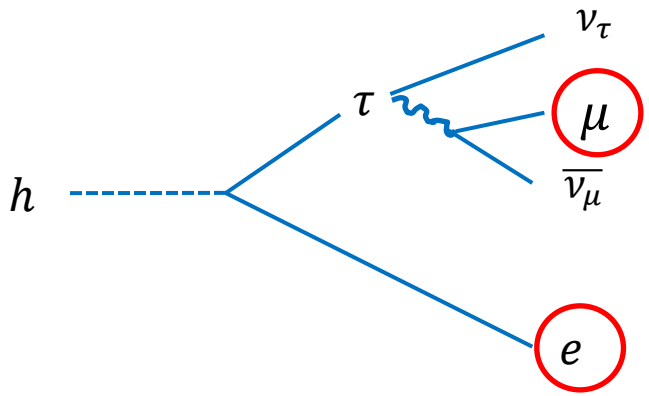

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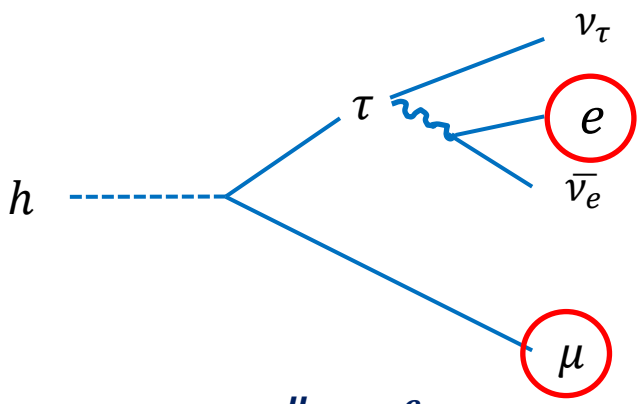
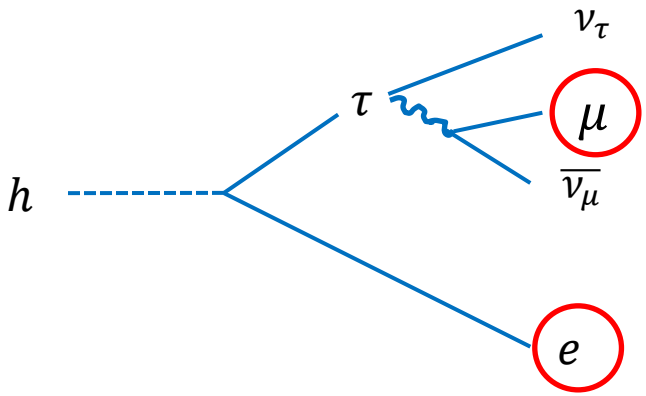


$p_T^\mu > p_T^e$



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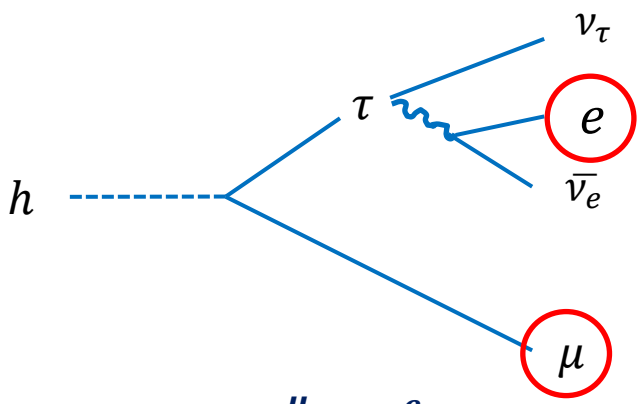
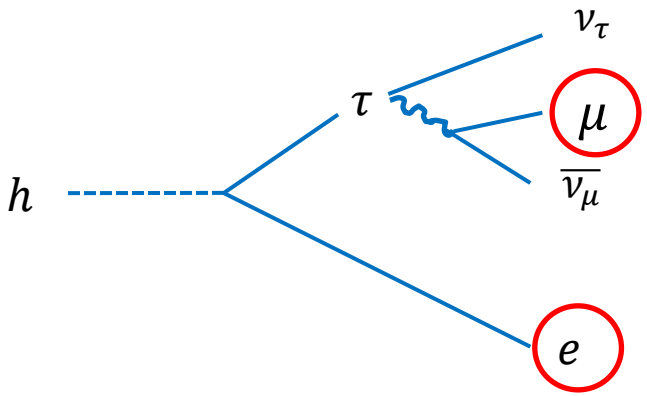


$\boldsymbol{p_T^\mu > p_T^e}$

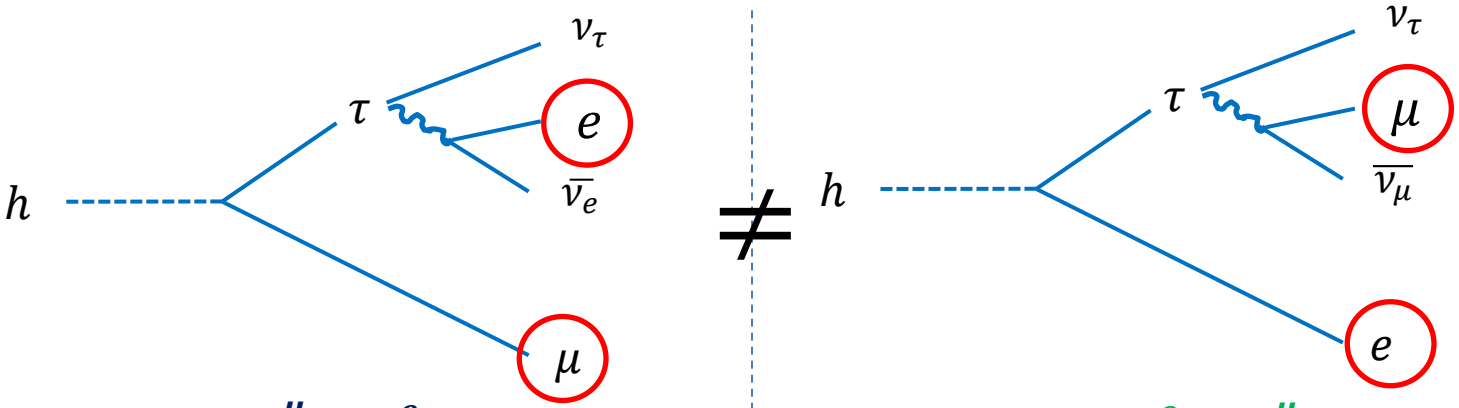
$\boldsymbol{\mu e}$ sample



$\boldsymbol{p_T^e > p_T^\mu}$

$\boldsymbol{e\mu}$ sample

Asymmetric Lepton Flavor Violating Higgs Decays

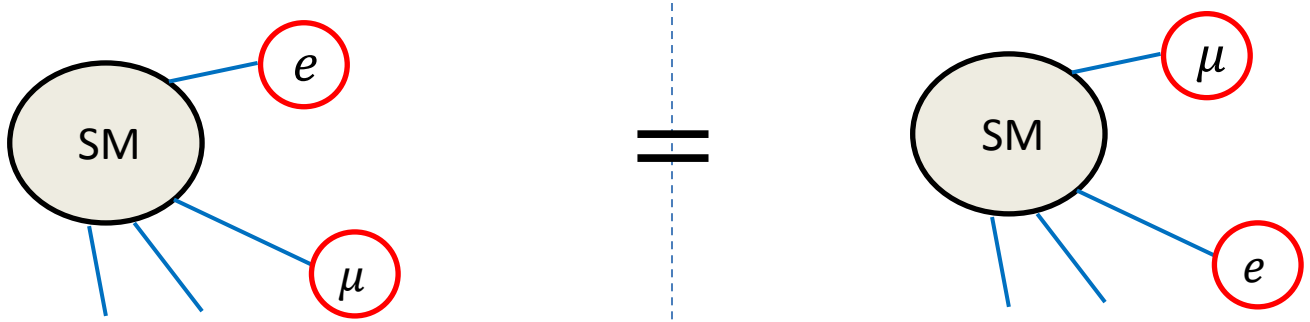


$p_T^\mu > p_T^e$

μe sample

$p_T^e > p_T^\mu$

$e\mu$ sample



Asymmetric Lepton Flavor Violating Higgs Decays

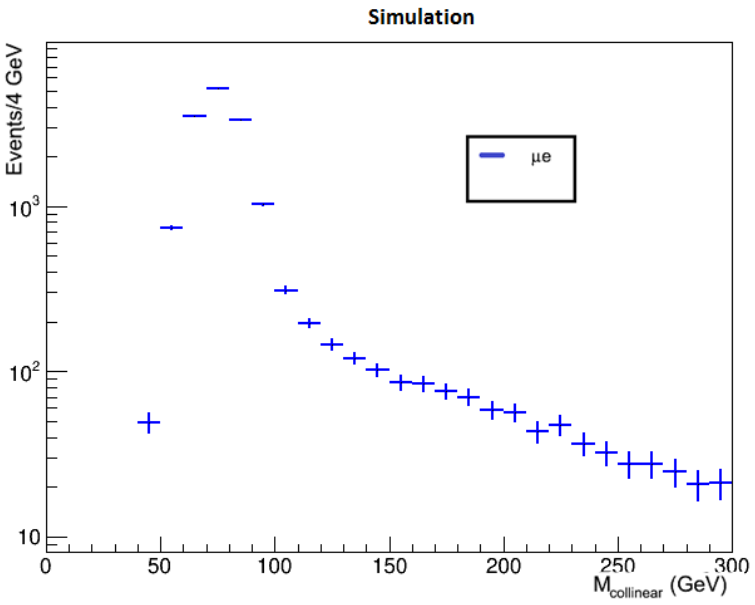
! Experimentally, electrons and muons are very different objects:

- trigger / reconstruction efficiencies
- Fake rates
- Bremsstrahlung
- Energy resolution
- …

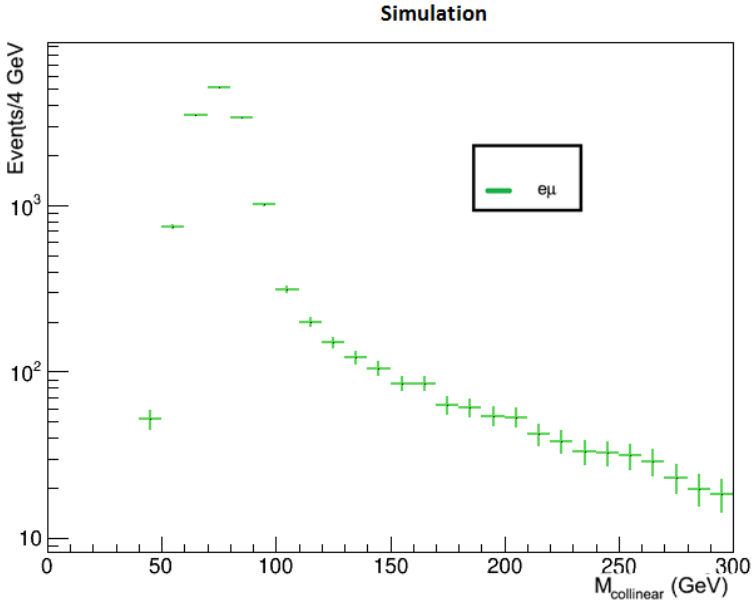
The fact that we have <u>both objects in the final states</u> preserves the symmetry at leading order.

Asymmetric Lepton Flavor Violating Higgs Decays

μe sample

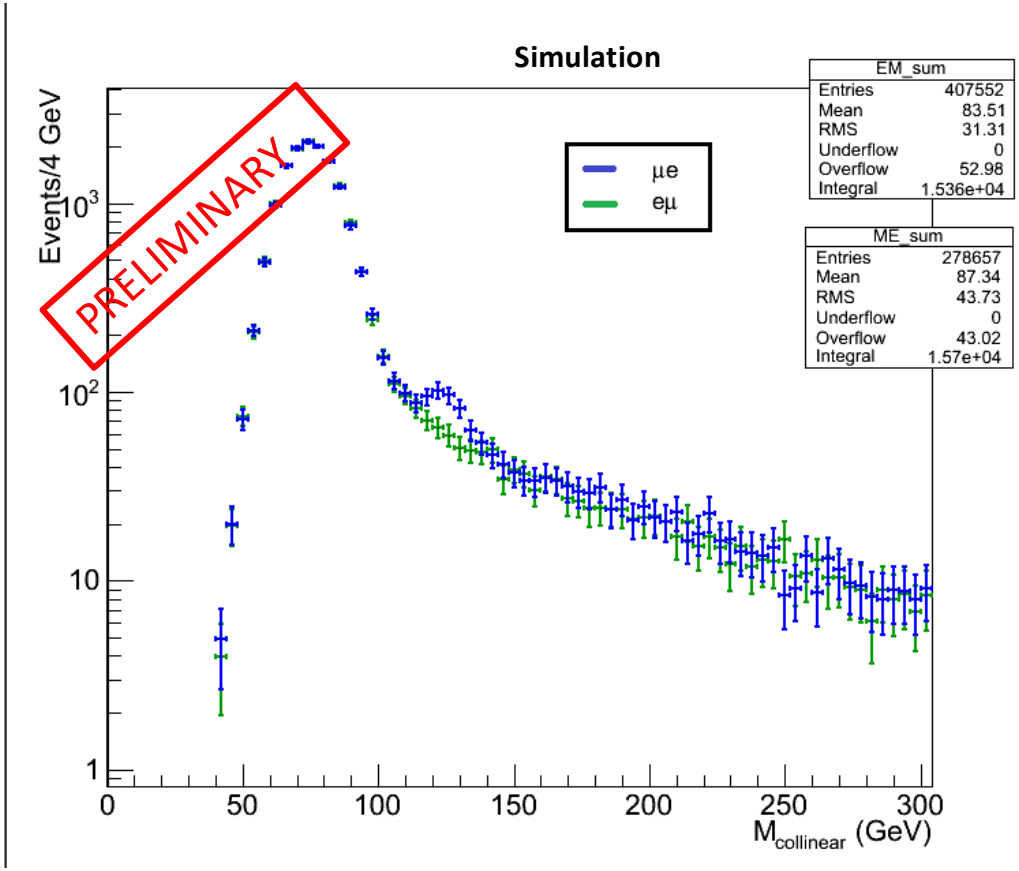


eμ sample



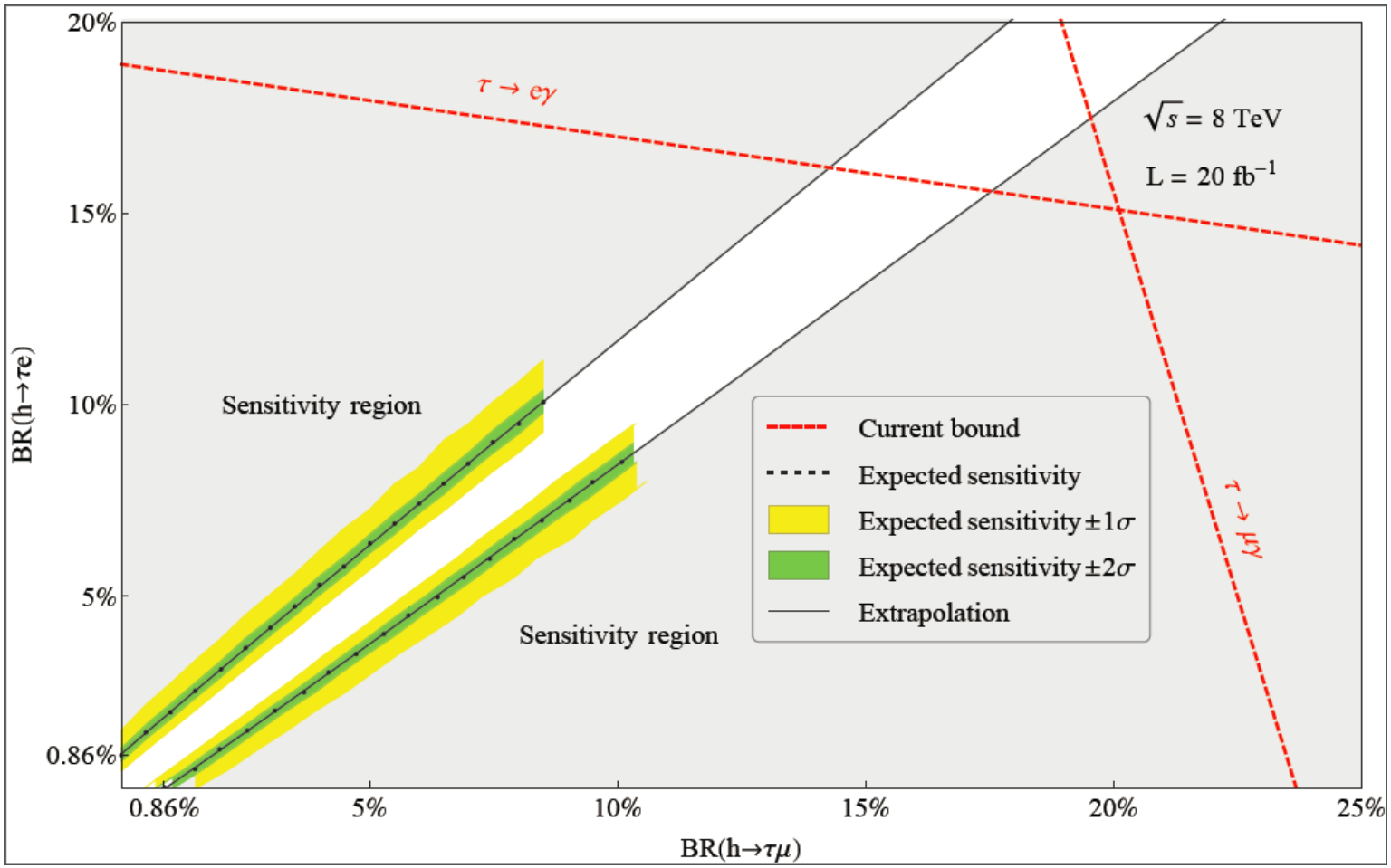
SM Background

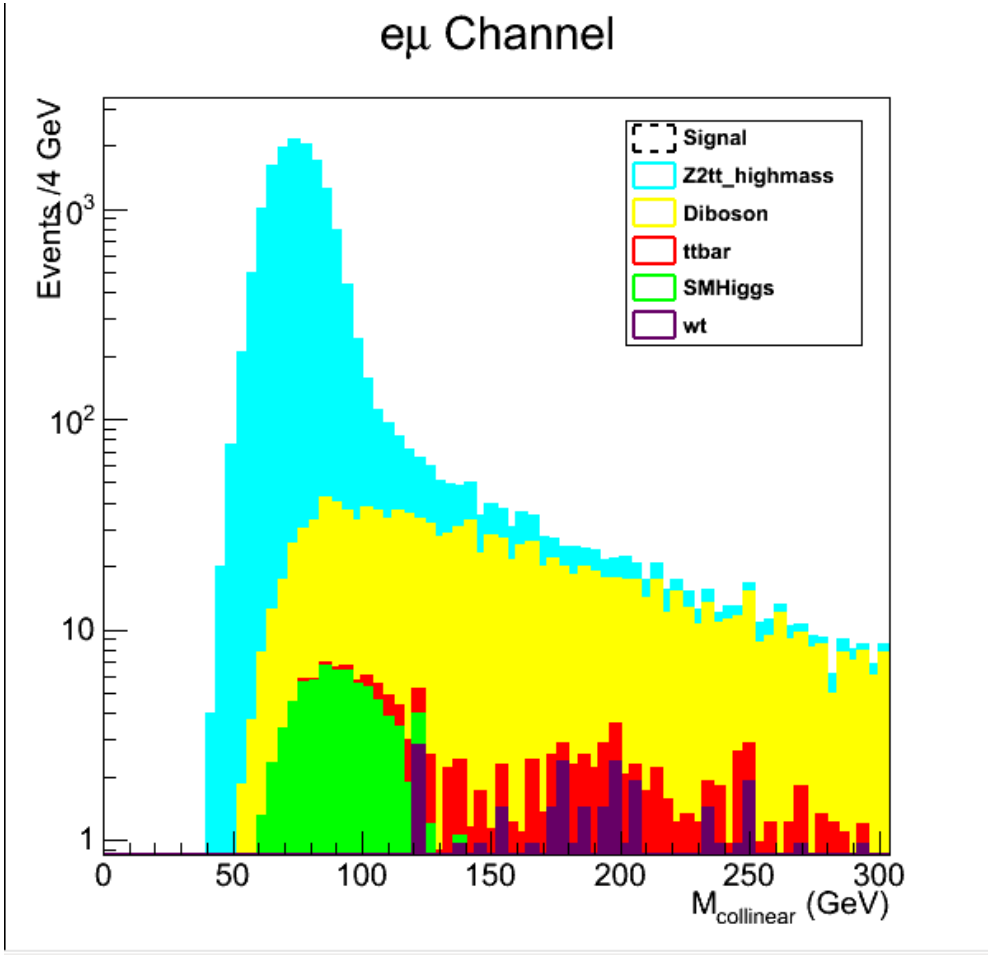
Asymmetric Lepton Flavor Violating Higgs Decays

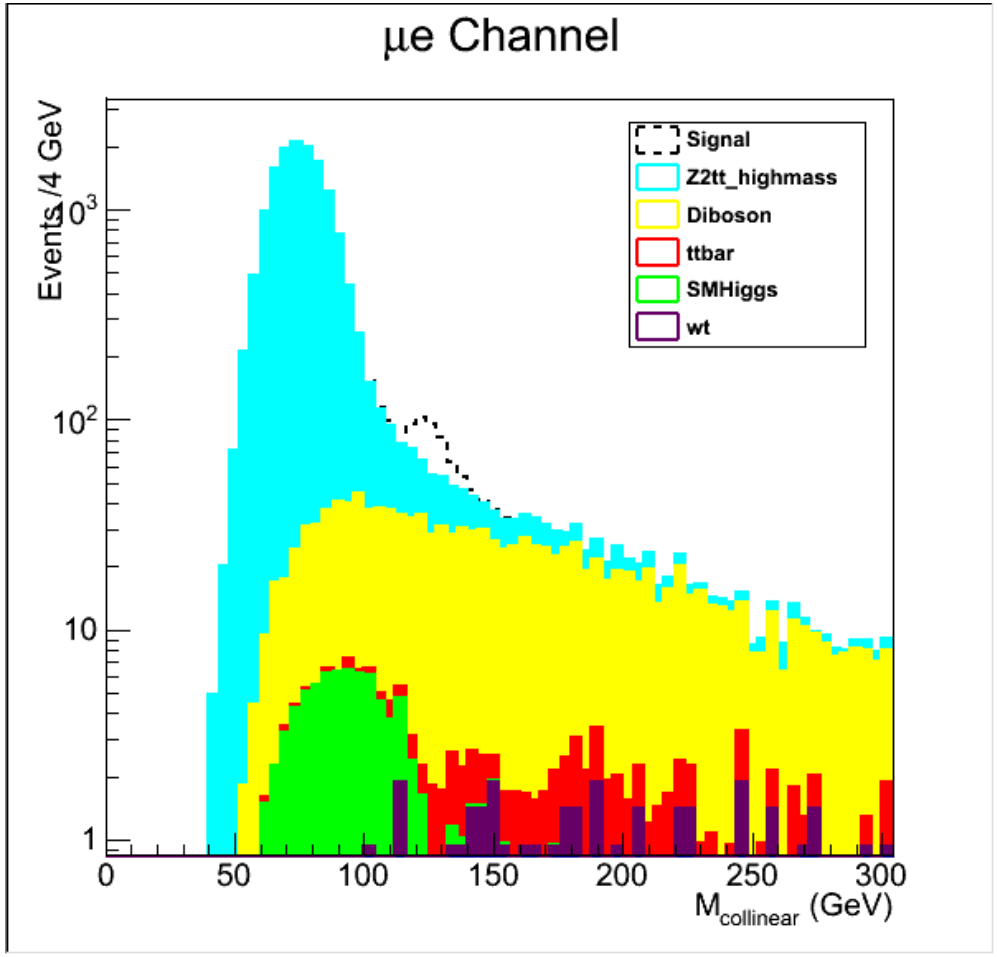


SM Background + $h \rightarrow \tau\mu$ signal

Questions Please


20%
15%
10%
5%
0.86%
BR(h→τe)
0.86%
5%
10%
15%
20%
25%
BR(h→τμ)
τ → eγ
τ → μγ
√s = 8 TeV
L = 20 fb−1
Sensitivity region
Sensitivity region
Current bound
Expected sensitivity
Expected sensitivity ±1σ
Expected sensitivity ±2σ
Extrapolation


eμ Channel
Events /4 GeV
10^3
10^2
10
1
0
50
100
150
200
250
300
$M_{collinear}$ (GeV)
Signal
Z2tt_highmass
Diboson
ttbar
SMHiggs
wt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(charged) Lepton Flavor Violation
(and the Higgs)

Leptons	
charged	neutral
e	ν_e
μ	ν_μ
τ	ν_τ

The Higgs was discovered. (have you heard??)

$\Rightarrow$ **A new arena for Flavor Physics** $\quad L = Y_{ij} h \bar{L}_i L_j$

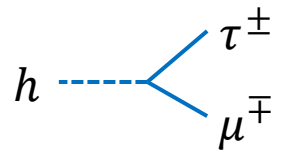
Within the SM: $\quad \frac{Y_{\tau\tau}}{Y_{\mu\mu}} = \frac{m_\tau}{m_\mu} \approx 10; \qquad Y_{\tau\mu} = Y_{\tau e} = 0$

Very recent results of ATLAS & CMS provide a first look at the flavor structure of the couplings:

* $\left|\frac{Y_{\tau\tau}}{Y_{\mu\mu}}\right| > 5$

[ATLAS-CONF-2013-108]
[CMS PAS HIG-13-007]

Could there also be **non-diagonal** couplings (=Flavor Violation)?



* Assuming SM $pp \to h$ production, at 2σ