Study of $h, H, A \to \tau\mu$ decays in the context of the MSSM within the Mass Insertion Approximation

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Outline

- Motivation
- Experimental Bounds
- MSSM + general slepton mixing
- Mass Insertion Approximation (MIA)
- Lepton Flavor Violation Higgs Decays (LFVHD) processes
- Results
- Phenomenology
- Conclusions

References

Work based on:

- E.Arganda, M. J. Herrero, R. Morales and A. Szynkman,
  "Analysis of the $h, H, A \to \tau\mu$ decays induced from SUSY loops within the Mass Insertion Aproximation", arXiv:1510.04685[hep-ph].

In continuation to:

- M. Arana-Catania, E.Arganda and M. J. Herrero,
  "Non-decoupling SUSY in LFV Higgs decays: a window to new physics at the LHC", JHEP **1309** (2013) 160 [JHEP **1510** (2015) 192] [arXiv:1304.3371 [hep-ph]].

Motivation

- Why Lepton Flavor Violation? LFV occurs in Nature.
  Neutrino oscillations $\longrightarrow$ LFV
- LFV is a window to BSM physics: No LFV within SM.
- SUSY not seen yet at LHC (scale m_{SUSY} at TeV range?)
- Higgs mediated processes are sensitive to SUSY via loops.

Main here:

the MIA allows us to derive simple analytical expressions for decay rates. Useful for Pheno!

Experimental Bounds

Some searched processes:

LFV process	Present Upper Bound ($90\% CL$)	Future Sensitivity (?)
$\text{BR}(\mu \to e\gamma)$	5.7×10^{-13} (MEG 2013)	5×10^{-14} (MEGup)
$\text{BR}(\tau \to e\gamma)$	3.3×10^{-8} (BaBar 2010)	3×10^{-9} (SuperB)
$\text{BR}(\tau \to \mu\gamma)$	4.4×10^{-8} (BaBar 2010)	2.4×10^{-8} (SuperB)
$\text{BR}(\mu \to eee)$	1×10^{-12} (SINDRUM 1988)	1×10^{-16} (Mu3E-PSI)
$\text{BR}(\tau \to eee)$	2.7×10^{-8} (Belle 2010)	$1 \times 10^{-9,-10}$ (Belle2, SuperB)
$\text{BR}(\tau \to \mu\mu\mu)$	2.1×10^{-8} (Belle 2010)	$1 \times 10^{-9,-10}$ (Belle2, SuperB)
$\text{BR}(\tau \to \mu\eta)$	2.3×10^{-8} (Belle 2010)	$1 \times 10^{-9,-10}$ (Belle2, SuperB)
$\text{CR}(\mu - e, \text{Au})$	7×10^{-13} (SINDRUM2 2006)	
$\text{CR}(\mu - e, \text{Al})$		3.1×10^{-15} (COMET-I, J-PARC)
		2.6×10^{-17} (COMET-II, J-PARC)
		2.5×10^{-17} (Mu2E-FermiLab)
$\text{CR}(\mu - e, \text{Ti})$	4.3×10^{-12} (SINDRUM2 2004)	1×10^{-18} (PRISM, J-PARC)

New input from LHC: LFV Higgs Decays

$\text{BR}(H \to \tau\mu) < 1.51 \times 10^{-2}$ (95%C.L.) [CMS 2015] (2.4σ excess?)

$\text{BR}(H \to \tau\mu) < 1.85 \times 10^{-2}$ (95%C.L.) [ATLAS 2015]

The MSSM with general slepton mixing

Low energy parametrization for general slepton mixing (model independent).

$$\mathcal{L}_{\rm soft}^{\rm LFV} = -\tilde{L}^\dagger m_{\tilde{L}}^2 \tilde{L} - \tilde{R}^* m_{\tilde{R}}^2 \tilde{R} + \left(\tilde{L}^\dagger \mathcal{A}^l \tilde{R}^* H_1 + h.c.\right)$$

$$m_{\tilde{L}}^2 = \begin{pmatrix} m_{\tilde{L}_1}^2 & \delta_{12}^{LL} m_{\tilde{L}_1} m_{\tilde{L}_2} & \delta_{13}^{LL} m_{\tilde{L}_1} m_{\tilde{L}_3} \\ \delta_{21}^{LL} m_{\tilde{L}_2} m_{\tilde{L}_1} & m_{\tilde{L}_2}^2 & \delta_{23}^{LL} m_{\tilde{L}_2} m_{\tilde{L}_3} \\ \delta_{31}^{LL} m_{\tilde{L}_3} m_{\tilde{L}_1} & \delta_{32}^{LL} m_{\tilde{L}_3} m_{\tilde{L}_2} & m_{\tilde{L}_3}^2 \end{pmatrix} \Bigg\} \Delta_{mk}^{LL} \equiv (m_{\tilde{L}}^2)_{mk} = \delta_{mk}^{LL} m_{\tilde{L}_m} m_{\tilde{L}_k}$$

$$m_{\tilde{R}}^2 = \begin{pmatrix} m_{\tilde{R}_1}^2 & \delta_{12}^{RR} m_{\tilde{R}_1} m_{\tilde{R}_2} & \delta_{13}^{RR} m_{\tilde{R}_1} m_{\tilde{R}_3} \\ \delta_{21}^{RR} m_{\tilde{R}_2} m_{\tilde{R}_1} & m_{\tilde{R}_2}^2 & \delta_{23}^{RR} m_{\tilde{R}_2} m_{\tilde{R}_3} \\ \delta_{31}^{RR} m_{\tilde{R}_3} m_{\tilde{R}_1} & \delta_{32}^{RR} m_{\tilde{R}_3} m_{\tilde{R}_2} & m_{\tilde{R}_3}^2 \end{pmatrix} \Bigg\} \Delta_{mk}^{RR} \equiv (m_{\tilde{R}}^2)_{mk} = \delta_{mk}^{RR} m_{\tilde{R}_m} m_{\tilde{R}_k}$$

$$v_1 \mathcal{A}^l = \begin{pmatrix} m_e A_e & \delta_{12}^{LR} m_{\tilde{L}_1} m_{\tilde{R}_2} & \delta_{13}^{LR} m_{\tilde{L}_1} m_{\tilde{R}_3} \\ \delta_{21}^{LR} m_{\tilde{L}_2} m_{\tilde{R}_1} & m_\mu A_\mu & \delta_{23}^{LR} m_{\tilde{L}_2} m_{\tilde{R}_3} \\ \delta_{31}^{LR} m_{\tilde{L}_3} m_{\tilde{R}_1} & \delta_{32}^{LR} m_{\tilde{L}_3} m_{\tilde{R}_2} & m_\tau A_\tau \end{pmatrix}$$

$$\Delta_{mk}^{LR} \equiv (v_1 \mathcal{A}^l)_{mk} = \tilde{\delta}_{mk}^{LR} v_1 \sqrt{m_{\tilde{L}_m} m_{\tilde{R}_k}} \Longrightarrow \delta_{mk}^{LR} = \tilde{\delta}_{mk}^{LR} \frac{v_1}{\sqrt{m_{\tilde{L}_m} m_{\tilde{R}_k}}}$$

$$\Delta_{mk}^{RL} \equiv (v_1 \mathcal{A}^l)_{km} = \tilde{\delta}_{mk}^{RL} v_1 \sqrt{m_{\tilde{R}_m} m_{\tilde{L}_k}} \Longrightarrow \delta_{mk}^{RL} = \tilde{\delta}_{mk}^{RL} \frac{v_1}{\sqrt{m_{\tilde{R}_m} m_{\tilde{L}_k}}}$$

$$v_{1(2)} = \langle H_{1(2)} \rangle \quad \text{and} \quad \tan\beta = t_\beta = v_2/v_1$$

⇒ LFV is originated from the off-diagonal real δ_{mk}^{AB}'s via SUSY loops.

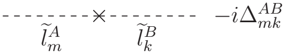
Full and MIA approach

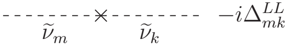
Full Calculation

- Work with the mass basis $\longrightarrow$ full diagonalization of mass matrix.
- Physical states: 6 sleptons $\tilde{l}_\alpha$ and 3 sneutrinos $\tilde{\nu}_\alpha$.
- Dependence on δ_{mk}^{AB} hidden in physical masses and rotation matrices.
- Numerical results for decay rates.

MIA Calculation

- Work with the EW interaction basis. Gauge states: $\tilde{l}_i^L$, $\tilde{l}_i^R$ and $\tilde{\nu}_i$ where i denotes flavor e, μ, τ.
- Non-diagonal elements of the mass matrix are considered as two-field interactions. For example, explicit dependence on Δ_{mk}^{AB} appears in the lepton flavor violation insertions:

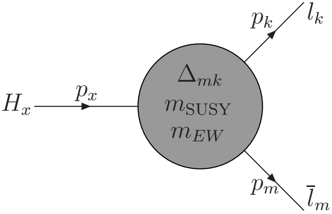




- Analytical expressions for decay rates as perturbative expansion of δ_{mk}^{AB} and other mass ratios.

LFVHD processes $h, H, A \to l_k \bar{l}_m$ with $m \neq k$

In this context, LFV Higgs Decays occur at one-loop order:



Our aim:
to get the form factors F as an expansion valid for heavy SUSY
$(m_{\text{SUSY}} \gg m_{h,H,A}, m_{lep}, m_W)$

$$\Delta_{mk}^{AB} F(m_{H_x}, m_{lep}, m_W, m_{\text{SUSY}}) \sim \Delta_{mk}^{AB} \left(F|_{m_{ext}=0} + \mathcal{O}(M_{H_x}^2/m_{\text{SUSY}}^2) + \mathcal{O}(M_W^2/m_{\text{SUSY}}^2) \right)$$

$F|_{m_{ext}=0} \sim \mathcal{O}(M_{H_x}^0/m_{\text{SUSY}}^0) \longrightarrow$ Non-Decoupling ND contributions (dominant terms).

$\mathcal{O}(M_{H_x}^2/m_{\text{SUSY}}^2), \mathcal{O}(M_W^2/m_{\text{SUSY}}^2) \longrightarrow$ Decoupling D contributions (leading and subleading corrections).

Results for LFVHD in the MIA

In the next slides,

- SUSY scenarios: all heavy masses are proportional to one scale m_{SUSY}.
- All relevant one-loop diagrams for the full and MIA computation.
- Decay rate in terms of the form factors and Δ_{mk}^{AB}.
- Study of the cases Δ_{mk}^{LL} and Δ_{mk}^{RR}: Non-Decoupling behavior.
- Study of the cases Δ_{mk}^{LR} and Δ_{mk}^{RL}: Decoupling behavior.
- Perturbativity on δ_{mk}^{AB}'s.
- Comparison between MIA/Full calculation and with Effective approach.
- Pheno implications: numerical study of maximum rates allowed by experimental bounds from $\tau \to \mu\gamma$ and searches of neutral MSSM Higgs bosons.

SUSY scenarios

- *Equal masses* scenario: all the relevant parameters involved set to be equal

$$M_1 = M_2 = \mu = m_{\tilde{L}} = m_{\tilde{R}} = A_\mu = A_\tau = m_{\rm SUSY}$$

- *GUT approximation* scenario: set an approximate GUT relation for the gaugino masses

$$M_2 = 2M_1 \qquad \text{(GUT relation)}$$

We also relate the soft parameters and the μ parameter to a common scale by choosing:

$$m_{\tilde{L}} = m_{\tilde{R}} = M_2 = A_\mu = A_\tau = \mu/a = m_{\rm SUSY} \qquad \text{with } a = \frac{3}{4}, \frac{4}{3}$$

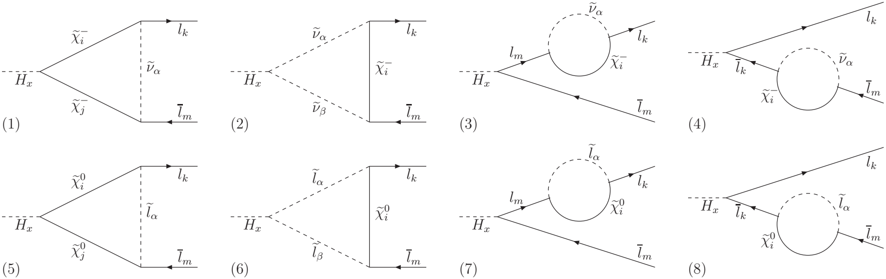
- *Generic* scenario: we set different values for all the mass parameters involved

$$\begin{aligned} M_1 &= 2.2\, m_{\rm SUSY}\,, M_2 = 2.4\, m_{\rm SUSY}\,, \mu = 2.1\, m_{\rm SUSY} \\ m_{\tilde{L}_1} &= 2\, m_{\rm SUSY}\,, m_{\tilde{L}_2} = 1.8\, m_{\rm SUSY}\,, m_{\tilde{L}_3} = 1.6\, m_{\rm SUSY} \\ m_{\tilde{R}_1} &= 1.4\, m_{\rm SUSY}\,, m_{\tilde{R}_2} = 1.2\, m_{\rm SUSY}\,, m_{\tilde{R}_3} = m_{\rm SUSY} \\ A_\mu &= 0.6\, m_{\rm SUSY}\,, A_\tau = 0.8\, m_{\rm SUSY} \end{aligned}$$

One-loop diagrams for the Full results

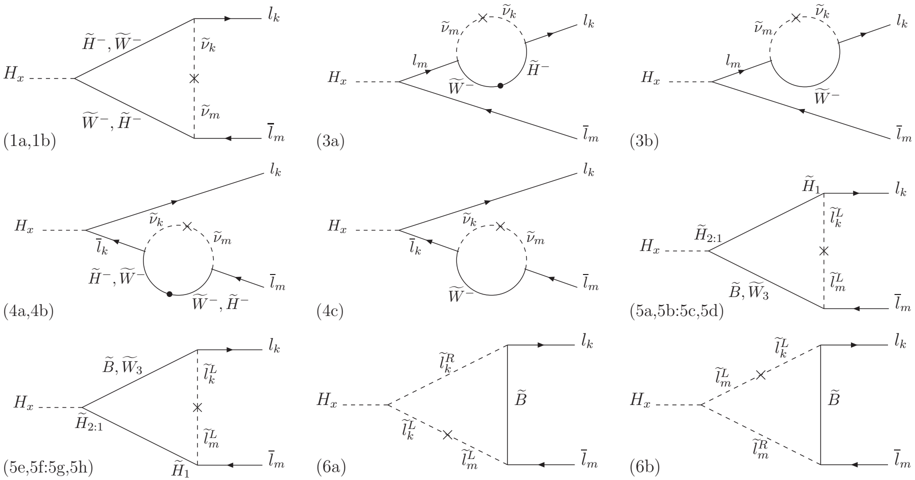
Use mass basis for the internal SUSY particles: sleptons, sneutrinos, charginos and neutralinos.

[Arganda, Curiel, Herrero, Temes; 2005]

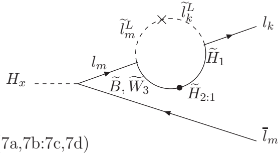


Relevant one-loop diagrams for Δ_{mk}^{LL}

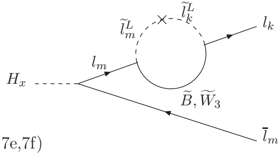
Use gauge basis for the internal SUSY particles: flavor sleptons, flavor sneutrinos, Bino, Winos, Higgsinos.



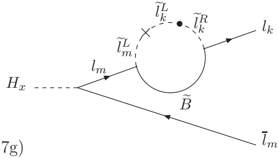
Relevant one-loop diagrams for Δ^{LL}_{mk}



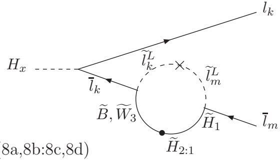
(7a,7b:7c,7d)



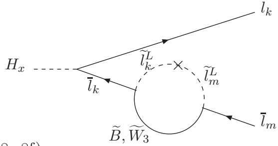
(7e,7f)



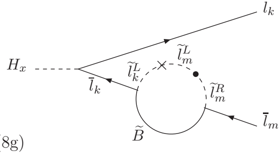
(7g)



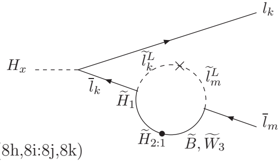
(8a,8b:8c,8d)



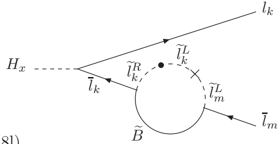
(8e,8f)



(8g)



(8h,8i:8j,8k)

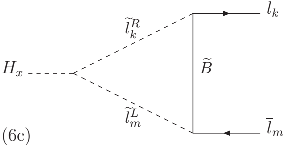


(8l)

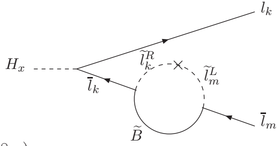
Other diagrams suppressed by extra factors of $(M_{EW}/m_{\rm SUSY})^n$ and/or $(m_{lep}/m_{\rm SUSY})^m$.

Relevant one-loop diagrams for Δ_{mk}^{LR} and Δ_{mk}^{RL}

- Case Δ_{mk}^{LR}

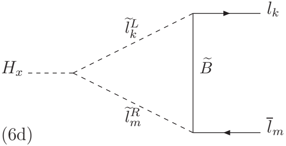


(6c)

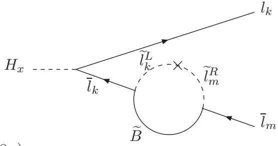


(8m)

- Case Δ_{mk}^{RL}

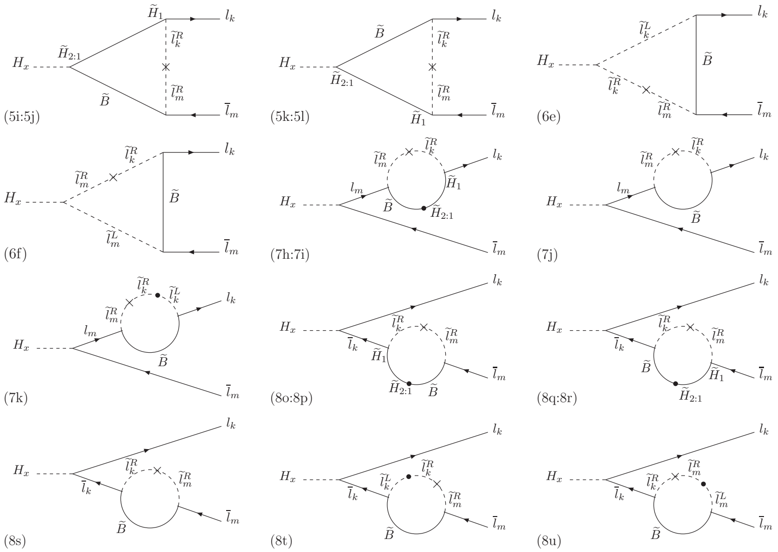


(6d)



(8n)

Relevant one-loop diagrams for Δ_{mk}^{RR}



Analytical results in the MIA

The amplitude of $H_x(p_1) \to l_k(-p_2)\bar{l}_m(p_3)$ for $H_x = h, H, A$ is

$$i\mathcal{M} = -ig\bar{u}_{l_k}(-p_2)(F_L^{(x)}P_L + F_R^{(x)}P_R)v_{l_m}(p_3)$$

The decay rate reads as follows:

$$\Gamma(H_x \to l_k\bar{l}_m) = \frac{g^2}{16\pi m_{H_x}}\sqrt{\left(1-\left(\frac{m_{l_k}+m_{l_m}}{m_{H_x}}\right)^2\right)\left(1-\left(\frac{m_{l_k}-m_{l_m}}{m_{H_x}}\right)^2\right)}$$
$$\times\left((m_{H_x}^2 - m_{l_k}^2 - m_{l_m}^2)(|F_L^{(x)}|^2 + |F_R^{(x)}|^2) - 4m_{l_k}m_{l_m}Re(F_L^{(x)}F_R^{(x)*})\right)$$

where the form factors are linear in Δ_{mk}^{AB}

$$F_{L,R}^{(x)} = \Delta_{mk}^{LL}F_{L,R}^{(x)LL} + \Delta_{mk}^{LR}F_{L,R}^{(x)LR} + \Delta_{mk}^{RL}F_{L,R}^{(x)RL} + \Delta_{mk}^{RR}F_{L,R}^{(x)RR}$$

- All of them are UV convergent: they are expressed in terms of the loop functions C_0, C_2, D_0, $\tilde{D}_0$ of three and four points because there are 2 scalar and 1 fermionic propagators at least.
- We perform a systematic expansion in powers of p_{ext} and keep: the leading contributions $\mathcal{O}(p_{ext}^0)$ and the next-to-leading $\mathcal{O}(p_{ext}^2)$.

Non-decoupling contributions for Δ^{LL}_{mk} and Δ^{RR}_{mk}

$$\left.\begin{array}{l}\left(\Delta_{23}^{LL} F_L^{(x)LL}\right)_{\rm ND} = \left(\frac{g^2}{16\pi^2}\frac{m_\tau}{2M_W}\right)\left[\frac{\sigma_2^{(x)} + \sigma_1^{(x)*} t_\beta}{c_\beta}\right](\delta_{23}^{LL} m_{\tilde{L}_2} m_{\tilde{L}_3}) \\ \quad \times \left[\frac{3}{2}\mu M_2 D_0(0,0,0,m_{\tilde{L}_2},m_{\tilde{L}_3},\mu,M_2)\right. \\ \quad -\frac{t_W^2}{2}\mu M_1 D_0(0,0,0,m_{\tilde{L}_2},m_{\tilde{L}_3},\mu,M_1) \\ \quad \left. -t_W^2 \mu M_1 D_0(0,0,0,m_{\tilde{L}_2},m_{\tilde{L}_3},m_{\tilde{R}_3},M_1)\right]\end{array}\right\} \mathcal{O}(M_{H_x}^0/m_{\rm SUSY}^0)$$

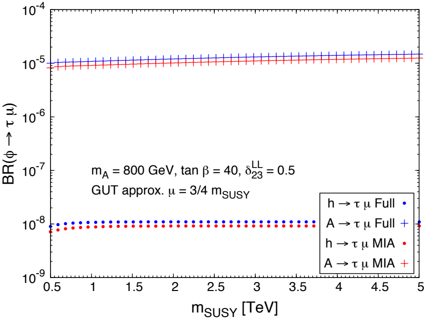
$$\left.\begin{array}{l}\left(\Delta_{23}^{RR} F_R^{(x)RR}\right)_{\rm ND} = \left(\frac{g^2 t_W^2}{16\pi^2}\frac{m_\tau}{2M_W}\right)\left[\frac{\sigma_2^{(x)*} + \sigma_1^{(x)} t_\beta}{c_\beta}\right](\delta_{23}^{RR} m_{\tilde{R}_2} m_{\tilde{R}_3}) \\ \quad \times \left[\mu M_1 D_0(0,0,0,m_{\tilde{R}_2},m_{\tilde{R}_3},\mu,M_1)\right. \\ \quad \left. -\mu M_1 D_0(0,0,0,m_{\tilde{R}_2},m_{\tilde{R}_3},m_{\tilde{L}_3},M_1)\right]\end{array}\right\} \mathcal{O}(M_{H_x}^0/m_{\rm SUSY}^0)$$

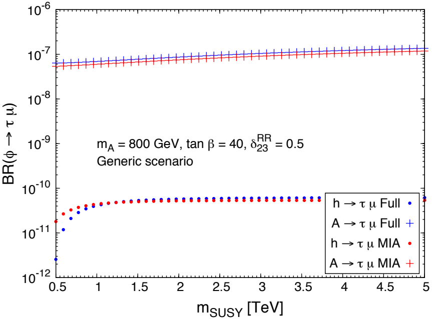
where

$$H_x = (h, H, A)\ , \sigma_1^{(x)} = (s_\alpha, -c_\alpha, i s_\beta)\ , \sigma_2^{(x)} = (c_\alpha, s_\alpha, -i c_\beta)$$

⇒ Simple analytical expressions: we factorized the contributions of the loops and the rest of MSSM parameters (t_β and m_A).

Non-decoupling contributions for Δ^{LL}_{mk} and Δ^{RR}_{mk}



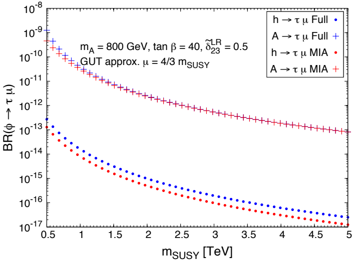


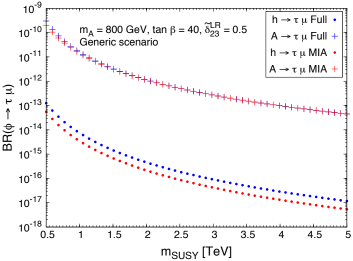
- Non-Decoupling behavior of $\mathrm{BR}(H_x \to \tau\mu) \sim m^0_{\mathrm{SUSY}}$ in contrast with the decoupling behavior of $\mathrm{BR}(\tau \to \mu\gamma) \sim m^{-4}_{\mathrm{SUSY}}$.
- First order MIA approximates the full calculation very well.
- Largest rates for LL and large t_β: $\mathrm{BR}(H_x \to \tau\mu) \sim t^2_\beta$.
- Similar results in other scenarios.

Decoupling contributions for Δ_{mk}^{LR} and Δ_{mk}^{RL}

$$\left.\begin{aligned}\left(\Delta_{23}^{LR} F_L^{(x)LR}\right)_{\rm D} = \left(\frac{g^2 t_W^2}{16\pi^2}\frac{M_1}{2M_W}\right)\left[\sigma_1^{(x)*}\right]\left(\tilde{\delta}_{23}^{LR} v \sqrt{m_{\tilde{L}_2} m_{\tilde{R}_3}}\right) \\ \times \left[-C_0(p_2, p_1, M_1, m_{\tilde{R}_3}, m_{\tilde{L}_2}) + C_0(p_3, 0, M_1, m_{\tilde{L}_2}, m_{\tilde{R}_3})\right]\end{aligned}\right\} \mathcal{O}(M_{H_x}^2/m_{\rm SUSY}^2)$$

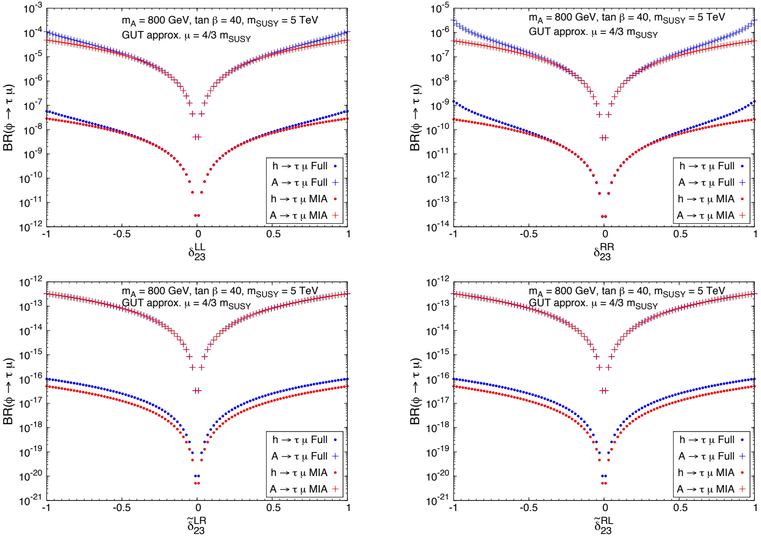
⇒ Simple analytical expressions: we factorized the contributions of the loops and the rest of MSSM parameters (t_β and m_A).





- Exact cancellations between Non-Decoupling terms.
- Decoupling behavior of BR($H_x \to \tau\mu$) $\sim m_{\rm SUSY}^{-4}$ like BR($\tau \to \mu\gamma$).
- First order MIA for H and A approximates the full calculation better than the h.
- Very small rates for LR and RL.
- Similar results in other scenarios.

Limitations of the MIA results



Perturbativity works reasonably well within $|\delta_{23}^{AB}| \leq \mathcal{O}(1)$.

Equal masses scenario: form factors

Dominant contributions for each δ:

$$F_{L,R}^{(x)} = \delta_{23}^{LL} \hat{F}_{L,R}^{(x)LL} + \tilde{\delta}_{23}^{LR} \hat{F}_{L,R}^{(x)LR} + \tilde{\delta}_{23}^{RL} \hat{F}_{L,R}^{(x)RL} + \delta_{23}^{RR} \hat{F}_{L,R}^{(x)RR}$$

As in the generic scenario, for δ_{23}^{LL} we get

$$\left.\hat{F}_L^{(x)LL} = \frac{g^2}{16\pi^2} \frac{m_\tau}{2M_W} \left[\frac{\sigma_2^{(x)} + \sigma_1^{(x)*} t_\beta}{c_\beta} \right] \frac{1 - t_W^2}{4} \quad \right\} \text{ND}$$

For $\delta_{23}^{LR}, \delta_{23}^{RL}, \delta_{23}^{RR}$, strong cancellations produce

$$\left.\begin{aligned} \hat{F}_L^{(x)LR} &= \frac{g t_W^2}{16\pi^2} \frac{1}{24\sqrt{2}} \left[\sigma_1^{(x)*} \right] \frac{m_{H_x}^2}{m_S^2} \\ \hat{F}_R^{(x)RL} &= \frac{g t_W^2}{16\pi^2} \frac{1}{24\sqrt{2}} \left[\sigma_1^{(x)} \right] \frac{m_{H_x}^2}{m_S^2} \\ \hat{F}_R^{(x)RR} &= -\frac{g^2 t_W^2}{16\pi^2} \frac{m_\tau}{2M_W} \left[\frac{2\sigma_2^{(x)*} + \sigma_1^{(x)}}{120 c_\beta} \right] \frac{m_{H_x}^2}{m_S^2} \end{aligned} \quad \right\} \text{D}$$

Equal masses scenario: simplest effective vertices

The most relevant mixing for phenomenology is δ_{23}^{LL}.
For this case, we can write the dominant effective vertex $-igV_{H_x\tau\mu}^{eff}\hat{P}_L$

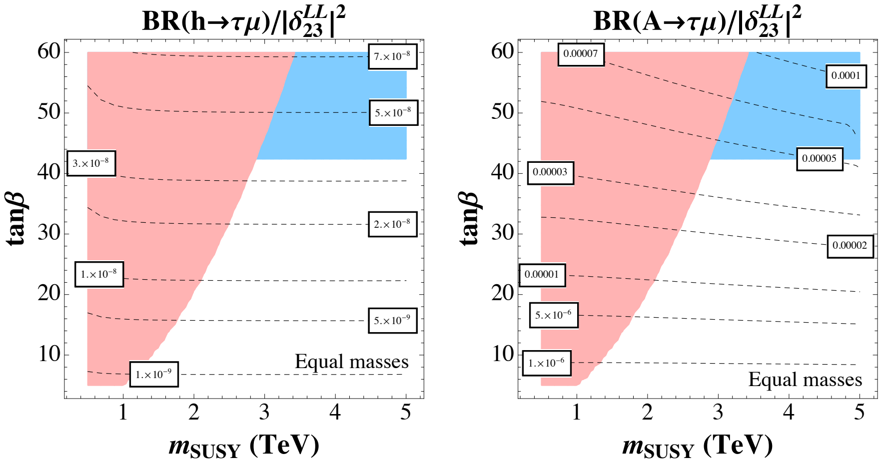
$$\boxed{V_{H_x\tau\mu}^{\text{eff}} = \frac{g^2}{16\pi^2}\frac{m_\tau}{2M_W}\left[\frac{\sigma_2^{(x)} + \sigma_1^{(x)^*} t_\beta}{c_\beta}\right]\left(\frac{1-t_W^2}{4}\right)\delta_{23}^{LL}}$$

In the large t_β limit:

$$\begin{aligned}
V_{h\tau\mu}^{\text{eff}}|_{t_\beta\gg 1} &= -\frac{g^2}{16\pi^2}\frac{m_\tau}{M_W}\frac{M_Z^2}{m_A^2}t_\beta\left(\frac{1-t_W^2}{4}\right)\delta_{23}^{LL} \\
V_{H\tau\mu}^{\text{eff}}|_{t_\beta\gg 1} &= -iV_{A\tau\mu}^{\text{eff}}|_{t_\beta\gg 1} = -\frac{g^2}{16\pi^2}\frac{m_\tau}{2M_W}t_\beta^2\left(\frac{1-t_W^2}{4}\right)\delta_{23}^{LL}
\end{aligned}$$

We deduce:

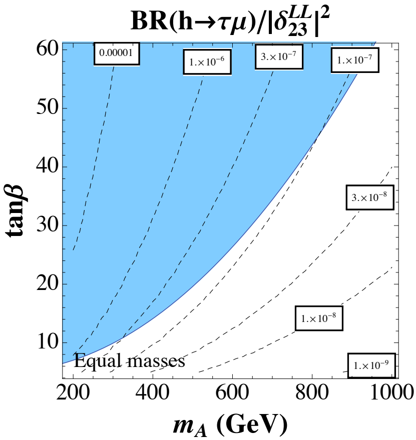
- For light Higgs: effective vertex suppressed by M_Z^2/m_A^2 ($m_A \to \infty$, h is SM-like).
- For heavy Higgs: effective vertex enhanced by t_β^2 (in agreement with [Brignole, Rossi; 2003])

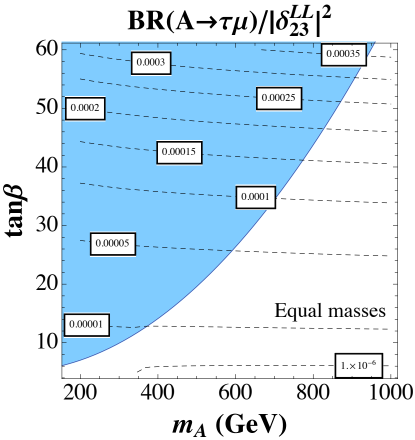


- Shaded pink area: excluded by $BR(\tau \to \mu\gamma) < 4.4 \times 10^{-8}$.
- Shaded blue area: excluded by negative searches by ATLAS and CMS of neutral MSSM Higgs bosons decaying to tau pairs.

$\Rightarrow$ Maximum allowed rates are $\sim 5 \times 10^{-5}$ for H and A (below LHC sensitivity).

Phenomenology

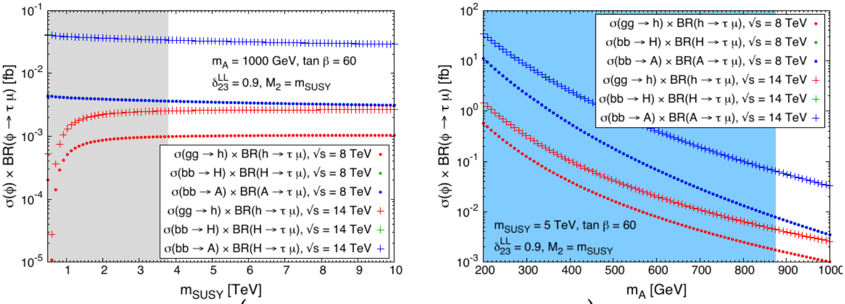




- We can set $m_{\text{SUSY}} = 4$ TeV (ND terms) $\longrightarrow$ no constraints by $\tau \to \mu\gamma$.
- Shaded blue area: excluded by negative searches by ATLAS and CMS of neutral MSSM Higgs bosons decaying to tau pairs.

$\Rightarrow$ Maximum allowed rates are $\sim 3.5 \times 10^{-4}$ for H and A.
Taking in account both channels $\tau\bar{\mu}$ and $\bar{\tau}\mu$, BR$\sim 10^{-3}$ closer to LHC sensitivity!

$h, H, A \to \tau\mu$ at LHC



(Cross sections computed with *FeynHiggs*)

- Shaded gray area: excluded by $\tau \to \mu\gamma$.
- Shaded blue area: excluded by negative searches by ATLAS and CMS.

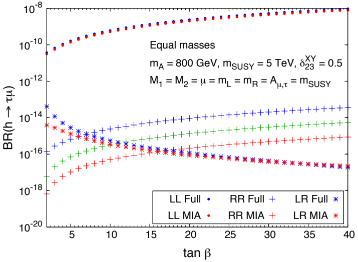
⇒ Most promising for H and A: in the region $t_\beta \sim 40 - 60$, $m_A \sim 900 - 1000$ GeV and $m_{SUSY} > 4$ TeV, for $\sqrt{s} = 14$ TeV and $\mathcal{L} \sim$100 fb^{-1} we predict $\mathcal{O}$(1-10) events.

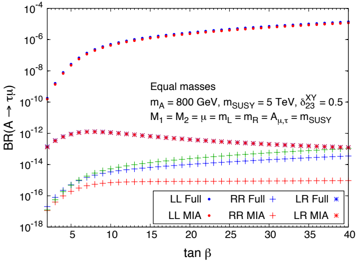
Conclusions

- We performed a diagramatic computation of LFVHD within the MIA. We found simple analytical expressions for the form factors. They are very useful for phenomenology and comparison with data.
- We compared MIA vs Full results: good agreement in most cases, in particular for the Non-Decopling terms (phenomenological important ones).
- Also, we compared with the effective vertices approach: in accordance with previous results in the literature.
- We understood the BR behavior with the MSSM parameters t_β and m_A.
- We concluded that $H, A \to \tau\mu$ are promising channels at the LHC.

Back-up

Subleading corrections: $\mathcal{O}(M_W^2/m_{\mathrm{SUSY}}^2)$





$$
\begin{aligned}
\tilde{F}_R^{(x)RR} \quad = \quad & \frac{g^2 t_W^2}{16\pi^2} \frac{m_\tau}{2M_W c_\beta} \frac{M_W^2}{m_S^2} \frac{t_\beta^2}{1+t_\beta^2} \left[\left(\frac{\sigma_1^{(x)}}{60} \left(3t_W^2 + 13 - 4t_W^2 t_\beta - 12 t_\beta\right) \right.\right. \\
& \left. - \frac{\sigma_1^{(x)*}}{5} - \frac{4\sigma_2^{(x)}}{15} - \frac{2\sigma_2^{(x)*}}{15} + \frac{\sigma_3^{(x)}\sqrt{1+t_\beta^2}}{12 t_\beta} \left(1 + t_W^2\right) \right) \\
& + \left(\frac{1+t_W^2}{60 t_\beta} \left(-8\sigma_1^{(x)} + 4\sigma_1^{(x)*} + \sigma_2^{(x)} + \sigma_2^{(x)*}\right) + \frac{\sigma_3^{(x)}\sqrt{1+t_\beta^2}}{12 t_\beta^2} \left(-1 + 5t_W^2\right) \right) \\
& \left. + \left(\frac{1+t_W^2}{30 t_\beta^2} \left(-\sigma_1^{(x)} + \sigma_1^{(x)*} + \sigma_2^{(x)} - \sigma_2^{(x)*}\right) \right) \right]
\end{aligned}
$$