Lepton flavour violating semileptonic τ decays in the CMSSM-seesaw model

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1. Framework

[E. Arganda, M.J. Herrero, J.P., 2008]

- **Use seesaw (Type I) for ν mass generation**
- **Work within CMSSM + 3 ν_R (Majorana) + 3 $\tilde{\nu}_R$**

Two scenarios for soft parameters at $M_X = 2 \times 10^{16}$ GeV:

- **Universal soft Higgs masses : CMSSM-seesaw**

$$\left(M_0, M_{1/2}, A_0, \tan\beta, \text{sign}(\mu)\right)$$

- **Non-universal soft Higgs masses : NUHM-seesaw**

$$\left(M_0, M_{1/2}, A_0, \tan\beta, \text{sign}(\mu), M_{H_1}, M_{H_2}\right) \longrightarrow M^2_{H_{1,2}} = M_0^2(1+\delta_{1,2})$$

LFV generated by 1-loop running from M_X to M_Z

Full RGEs including ν and $\tilde{\nu}$ sectors (No Llog approx)

Mass eigenstates for all SUSY and Higgs particles

- **Numerical estimates:** **Spheno 2.2.2 (W. Porod) for integration of REGs and SUSY spectrum.**

2. Processes

$\tau \to \mu PP$: $PP = \pi^+\pi^-, \pi^0\pi^0, K^+K^-, K^0\overline{K}^0$

$\tau \to \mu P$: $P = \pi^0, \eta, \eta'$

$\tau \to \mu\rho^0$

Input

$M_0 = M_{1/2} = M_{SUSY}$

$A_0 = 0$

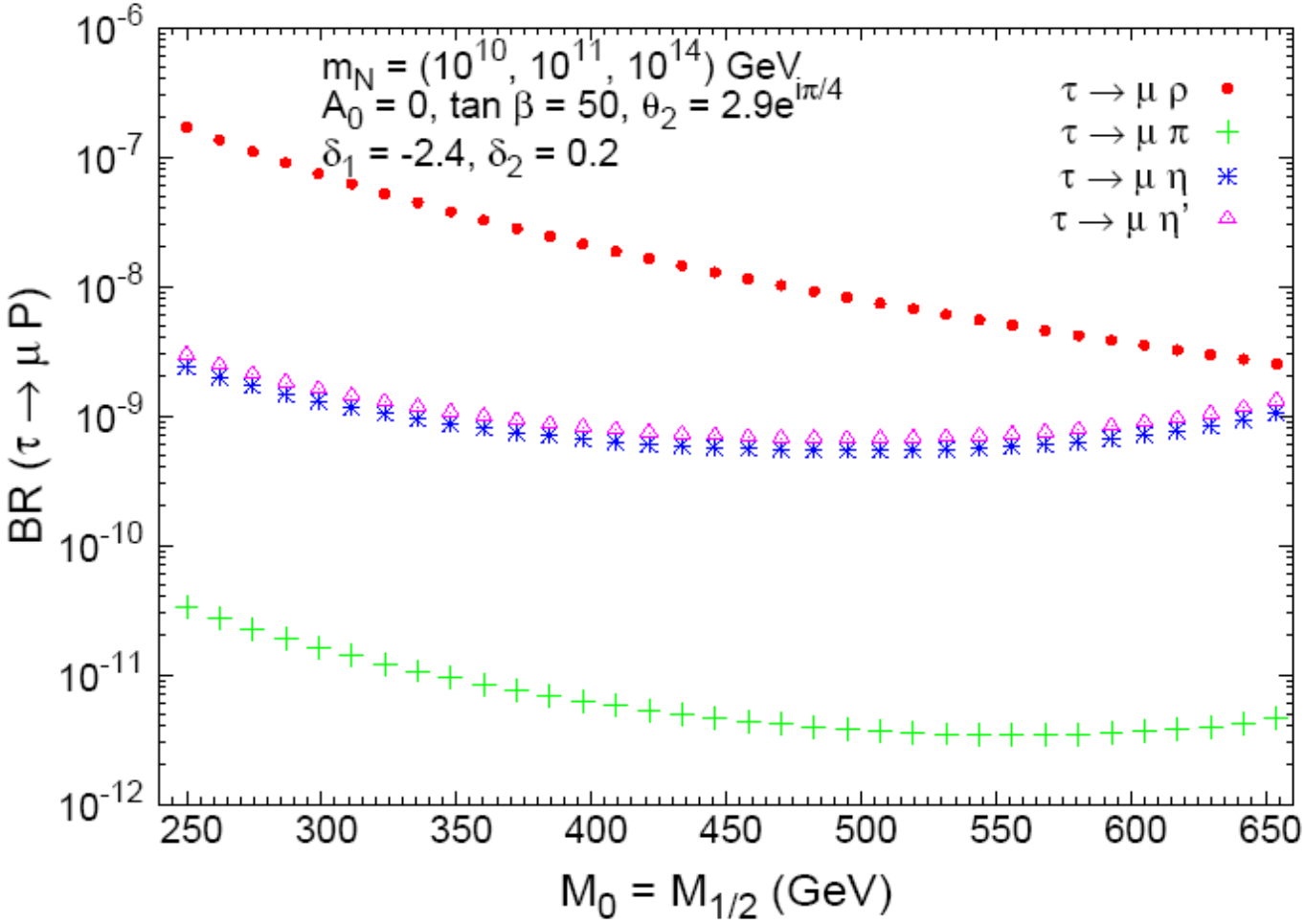
sig(μ) = +1

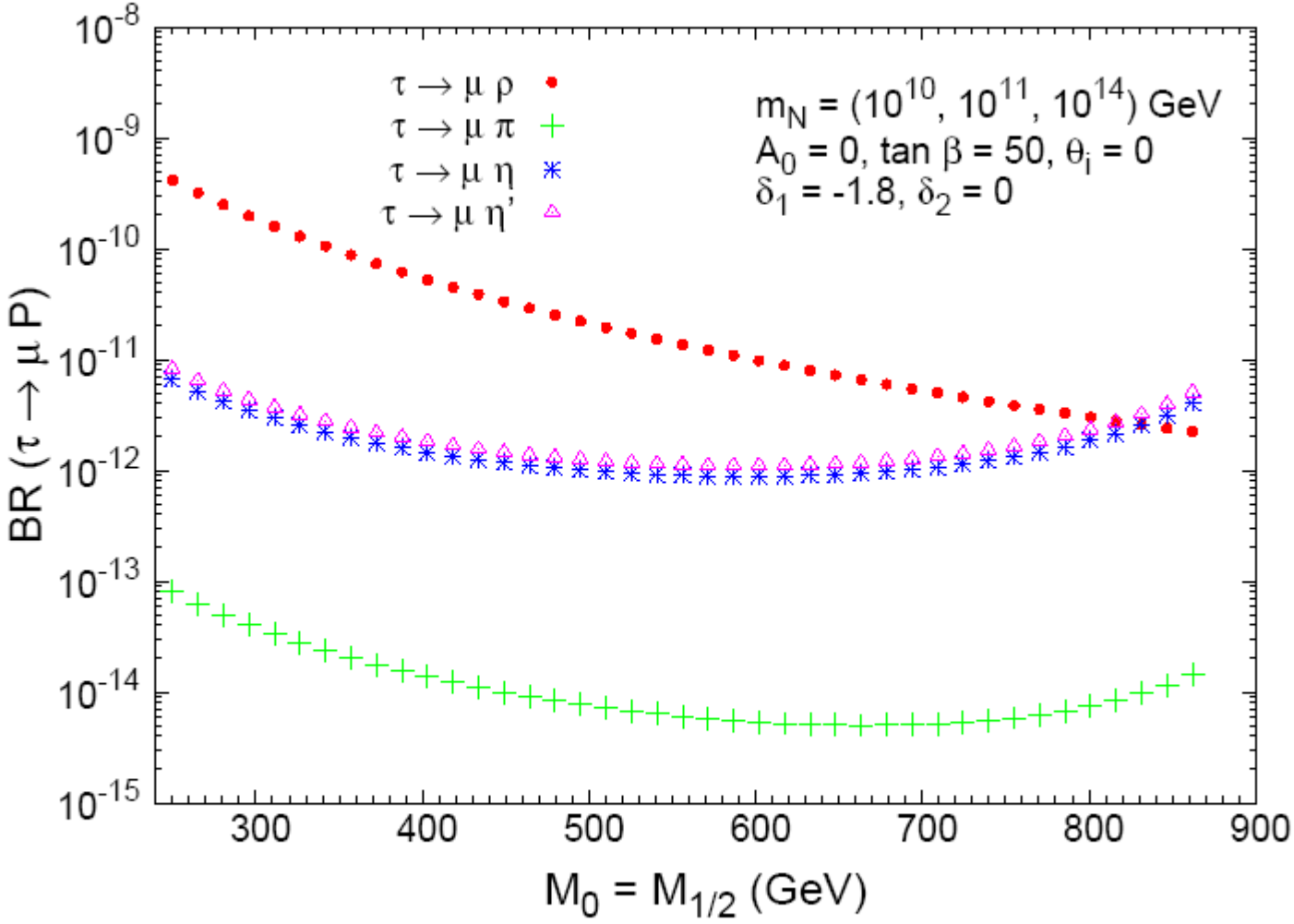
Hierarchical N's

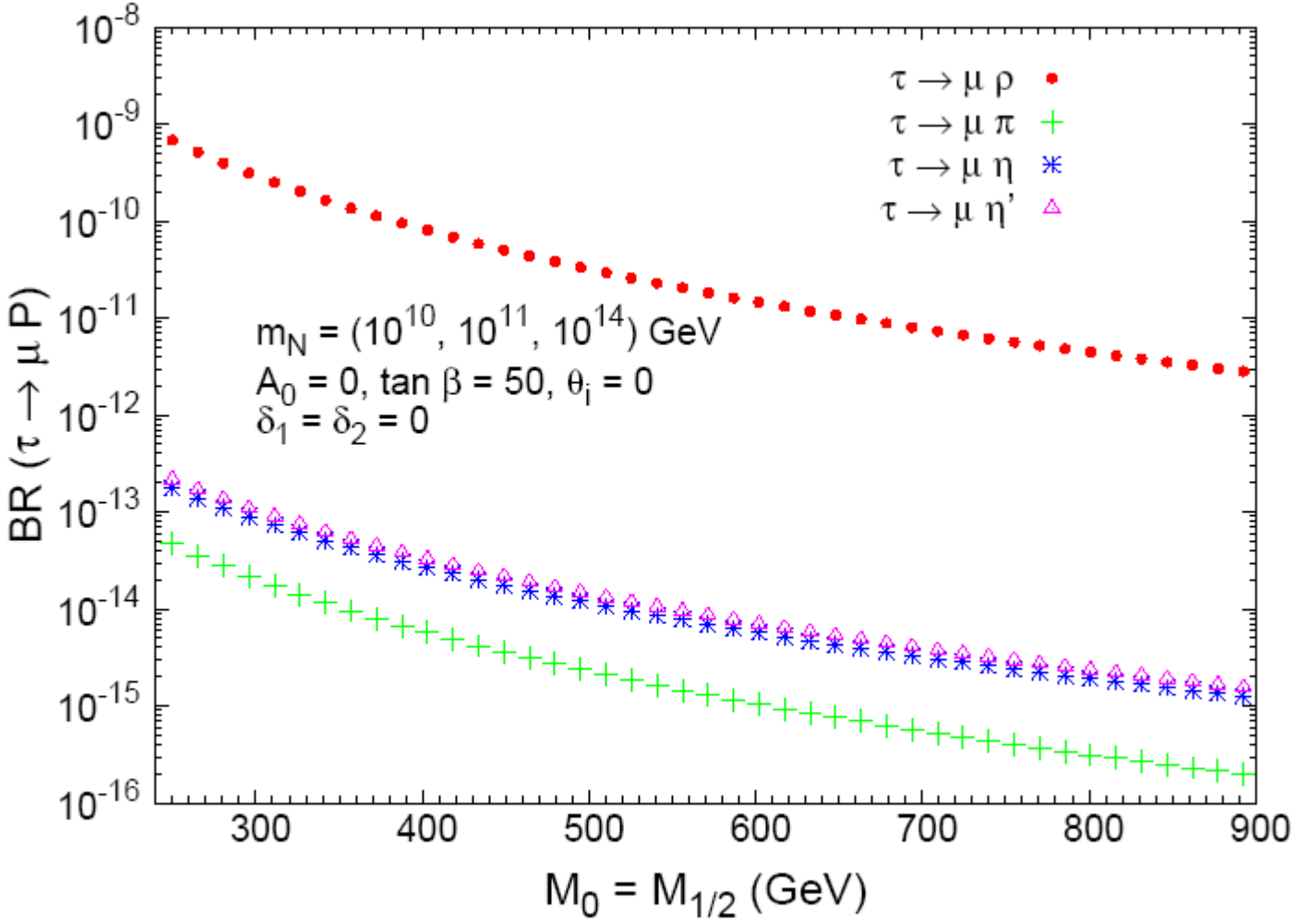
Upper bounds

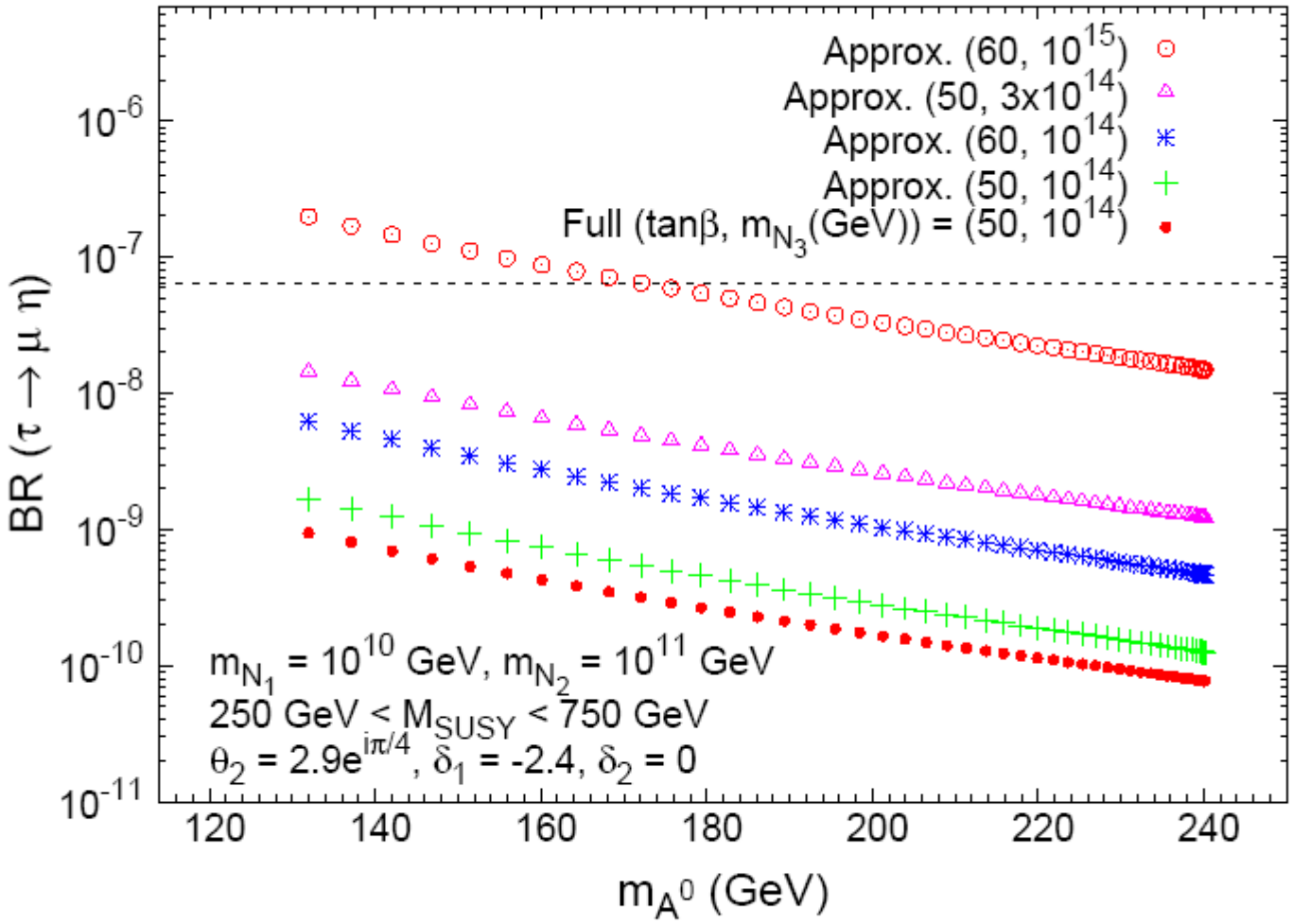
LFV τ decays	BELLE (X 10^7)	BABAR (X 10^7)
$BR(\tau \to \mu\eta)$	0.65	1.3
$BR(\tau \to \mu\eta')$	1.3	2.0
$BR(\tau \to \mu\pi^0)$	1.2	1.1
$BR(\tau \to \mu\rho^0)$	2.0	-
$BR(\tau \to \mu\pi^+\pi^-)$	4.8	-
$BR(\tau \to \mu\pi^0\pi^0)$	-	-
$BR(\tau \to \mu K^+K^-)$	8.0	-
$BR(\tau \to \mu K^0\overline{K}^0)$	-	-

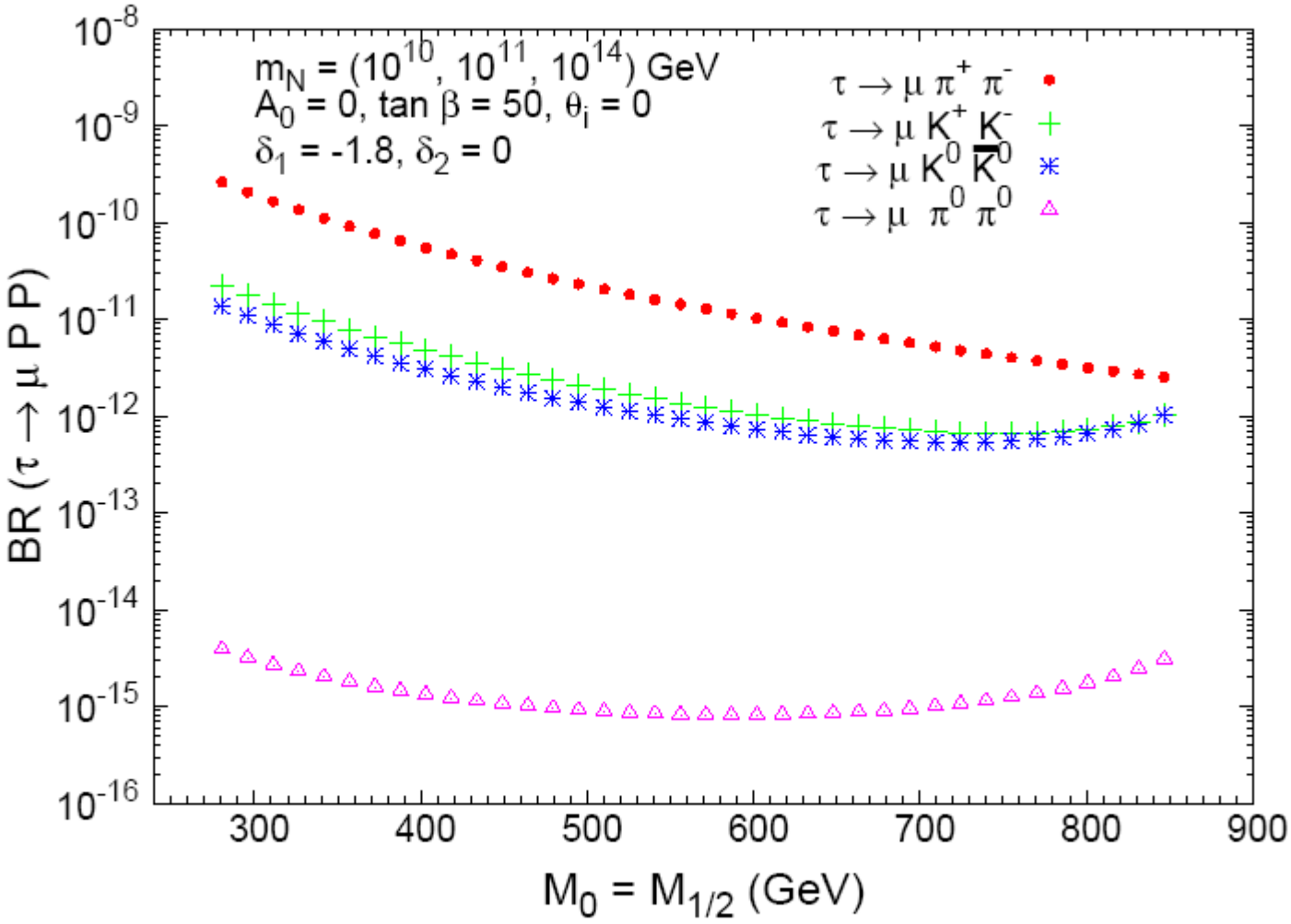
3. Results

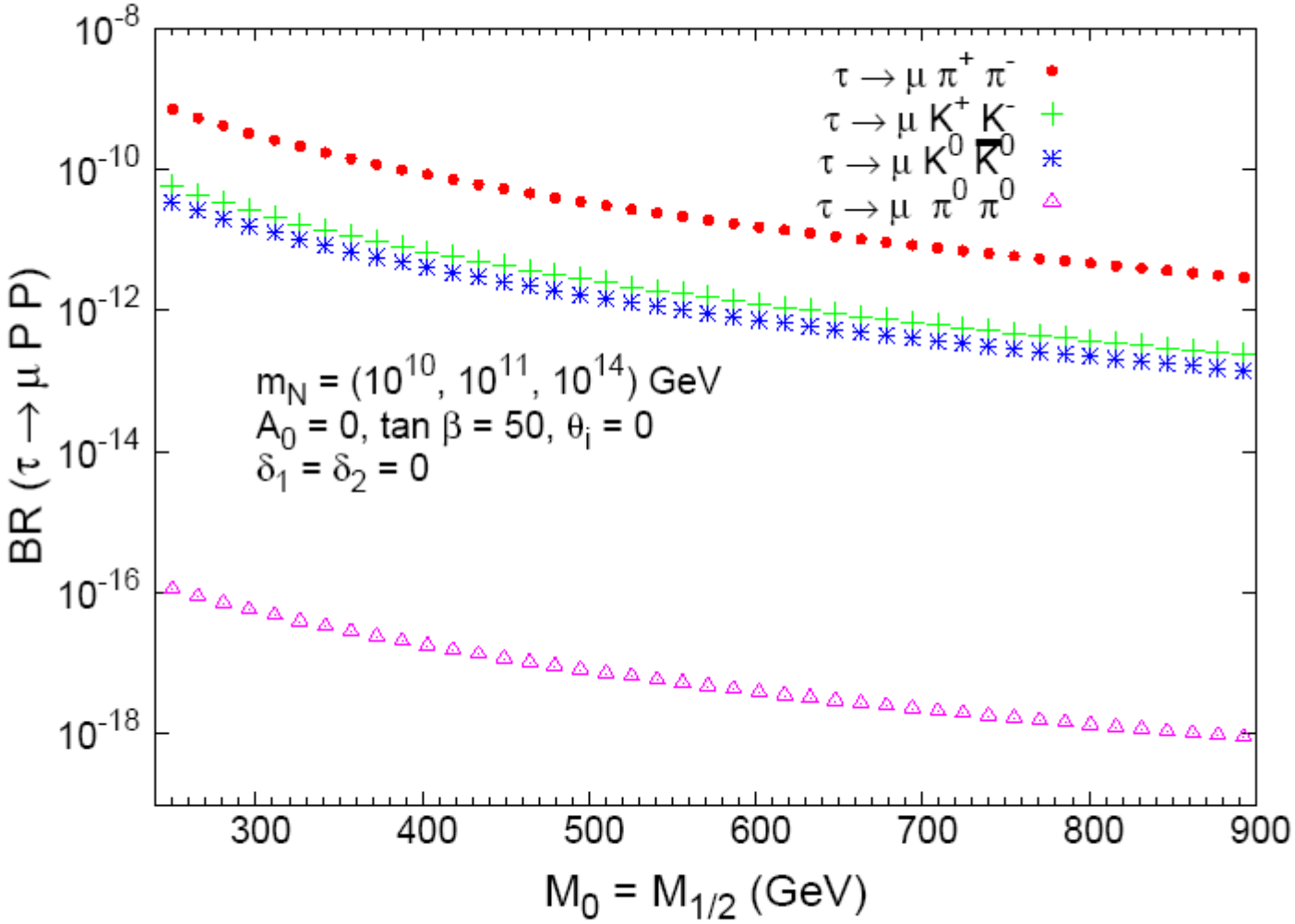

$m_N = (10^{10}, 10^{11}, 10^{14})$ GeV
$A_0 = 0$, $\tan\beta = 50$, $\theta_2 = 2.9e^{i\pi/4}$
$\delta_1 = -2.4$, $\delta_2 = 0.2$
$\tau \to \mu\ \rho$
$\tau \to \mu\ \pi$
$\tau \to \mu\ \eta$
$\tau \to \mu\ \eta'$
BR ($\tau \to \mu$ P)
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
250
300
350
400
450
500
550
600
650
$M_0 = M_{1/2}$ (GeV)


$\tau \to \mu\ \rho$
$\tau \to \mu\ \pi$
$\tau \to \mu\ \eta$
$\tau \to \mu\ \eta'$
$m_N = (10^{10}, 10^{11}, 10^{14})$ GeV
$A_0 = 0$, $\tan\beta = 50$, $\theta_i = 0$
$\delta_1 = -1.8$, $\delta_2 = 0$
BR ($\tau \to \mu$ P)
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
300
400
500
600
700
800
900
$M_0 = M_{1/2}$ (GeV)


10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
BR ($\tau \rightarrow \mu$ P)
300
400
500
600
700
800
900
$M_0 = M_{1/2}$ (GeV)
$\tau \rightarrow \mu\ \rho$
$\tau \rightarrow \mu\ \pi$
$\tau \rightarrow \mu\ \eta$
$\tau \rightarrow \mu\ \eta'$
$m_N = (10^{10}, 10^{11}, 10^{14})$ GeV
$A_0 = 0$, tan $\beta = 50$, $\theta_i = 0$
$\delta_1 = \delta_2 = 0$


Approx. (60, 10^{15})
Approx. (50, $3x10^{14}$)
Approx. (60, 10^{14})
Approx. (50, 10^{14})
Full (tanβ, m_{N_3}(GeV)) = (50, 10^{14})
BR (τ → μ η)
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
120
140
160
180
200
220
240
m_{A^0} (GeV)
m_{N_1} = 10^{10} GeV, m_{N_2} = 10^{11} GeV
250 GeV < M_{SUSY} < 750 GeV
$\theta_2 = 2.9e^{i\pi/4}$, δ_1 = -2.4, δ_2 = 0


$m_N = (10^{10}, 10^{11}, 10^{14})$ GeV
$A_0 = 0$, $\tan\beta = 50$, $\theta_i = 0$
$\delta_1 = -1.8$, $\delta_2 = 0$
$\tau \to \mu\ \pi^+\ \pi^-$
$\tau \to \mu\ K^+\ K^-$
$\tau \to \mu\ K^0\ \bar{K}^0$
$\tau \to \mu\ \pi^0\ \pi^0$
BR ($\tau \to \mu$ P P)
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
300
400
500
600
700
800
900
$M_0 = M_{1/2}$ (GeV)


10^{-8}
10^{-10}
10^{-12}
10^{-14}
10^{-16}
10^{-18}
BR ($\tau \to \mu$ P P)
300
400
500
600
700
800
900
$M_0 = M_{1/2}$ (GeV)
$\tau \to \mu\ \pi^+\ \pi^-$
$\tau \to \mu\ K^+\ K^-$
$\tau \to \mu\ K^0\ \bar{K}^0$
$\tau \to \mu\ \pi^0\ \pi^0$
$m_N = (10^{10}, 10^{11}, 10^{14})$ GeV
$A_0 = 0$, $\tan\beta = 50$, $\theta_i = 0$
$\delta_1 = \delta_2 = 0$