Imprint of SUSY in radiative B meson decays

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Contents

$\tilde{u}_{1,2}$

1. Introduction

- *We study supersymmetric (SUSY) effects on $C_7(\mu_b)$ and $C'_7(\mu_b)$ which are the Wilson coefficients (WC) for b -> s gamma at b quark mass scale μ_b and are closely related to radiative B meson decays.*
- *The SUSY-loop contributions to the $C_7(\mu_b)$ and $C'_7(\mu_b)$ are calculated in the Minimal Supersymmetric Standard Model (MSSM) with general quark flavor violation (QFV).*
- *In the computation of the WC's, we perform a MSSM parameter scan respecting all the relevant theoretical and experimental constraints, such as those from B-meson data, h(125)-boson data, and recent limits on SUSY particle masses from LHC experiments.*
- *Here we study a possibility that imprint of SUSY can be found in radiative B meson decays, focusing on the WC's $C_7(\mu_b)$ and $C'_7(\mu_b)$.*

2. MSSM with QFV

The basic parameters of the MSSM with QFV:

$\{\tan\beta, m_A, M_1, M_2, M_3, \mu, M^2_{Q,\alpha\beta}, M^2_{U,\alpha\beta}, M^2_{D,\alpha\beta}, T_{U\alpha\beta}, T_{D\alpha\beta}\}$

(at Q = 1 TeV scale)   (α,β = 1,2,3 = u, c, t or d, s, b)

$\tan\beta$: ratio of VEV of the two Higgs doublets $\langle H^0{}_2\rangle/\langle H^0{}_1\rangle$

m_A: CP odd Higgs boson mass (pole mass)

M_1, M_2, M_3: U(1), SU(2), SU(3) gaugino masses

μ: higgsino mass parameter

$M^2_{Q,\alpha\beta}$: left squark soft mass matrix

$M^2_{U\alpha\beta}$: right up-type squark soft mass matrix

$M^2_{D\alpha\beta}$: right down-type squark soft mass matrix

$T_{U\alpha\beta}$: trilinear coupling matrix of up-type squark and Higgs boson

$T_{D\alpha\beta}$: trilinear coupling matrix of down-type squark and Higgs boson

We work in the MSSM with real parameters, except for the CKM matrix.

Key parameters in this study are:

* *QFV parameters:* M^2_{Q23}, M^2_{U23}, M^2_{D23}, T_{U23}, T_{U32}, T_{D23}, T_{D32}

* *QFC parameter:* T_{U33}, T_{D33}

M^2_{Q23} = ($\tilde{c}_L - \tilde{t}_L$ mixing parameter)

M^2_{U23} = ($\tilde{c}_R - \tilde{t}_R$ mixing parameter)

M^2_{D23} = ($\tilde{s}_R - \tilde{b}_R$ mixing parameter)

T_{U23} = ($\tilde{c}_R - \tilde{t}_L$ mixing parameter)

T_{U32} = ($\tilde{c}_L - \tilde{t}_R$ mixing parameter)

T_{U33} = ($\tilde{t}_L - \tilde{t}_R$ mixing parameter)

T_{D23} = ($\tilde{s}_R - \tilde{b}_L$ mixing parameter)

T_{D32} = ($\tilde{s}_L - \tilde{b}_R$ mixing parameter)

T_{D33} = ($\tilde{b}_L - \tilde{b}_R$ mixing parameter)

3. Constraints on the MSSM

We respect the following experimental and theoretical constraints:

(1) The recent LHC limits on the masses of squarks, sleptons, gluino, charginos and neutralinos.

(2) The constraint on $(m_{A/H+}, \tan\beta)$ from recent MSSM Higgs boson search at LHC.

(3) The constraints on the QFV parameters from the B meson data.

$B(b \to s\gamma)$ ΔM_{Bs} $B(B_s \to \mu^+\mu^-)$ $B(B_u^+ \to \tau^+\nu)$ *etc.*

(4) The constraints from the observed Higgs boson mass and couplings at LHC ; e.g.

121.6 GeV < m_h^0 < 128.6 GeV (allowing for theoretical uncertainty) ,

$0.71 < \kappa_b < 1.43$ (ATLAS), $0.56 < \kappa_b < 1.70$ (CMS)

(5) Theoretical constraints from the vacuum stability conditions for the trilinear couplings T_{Uab} and T_{Dab}.

(6) The experimental limit on SUSY contributions to the electroweak ρ parameter

$\Delta\rho(SUSY) < 0.0012$.

4. Parameter scan in the MSSM

- *We compute the WC's $C_7(\mu_b)$ and $C'_7(\mu_b)$ at LO in the MSSM with QFV.*

- *Parameter points are generated by using random numbers in the following ranges (in units of GeV or GeV^2):*

1 TeV < M_{SUSY} < 5 TeV

10 < tanβ < 80
2500 < M_3 < 5000
100 < M_2 < 2500
100 < M_1 < 2500
(without assuming the GUT relation for M_1, M_2, M_3)
100 < μ < 2500
1350 < m_A(pole) < 6000;

MQ2_11 = 4500^2 (fixed)
2500^2 < MQ2_22 < 4000^2
2500^2 < MQ2_33 < 4000^2
|MQ2_23| < 1000.^2 *<=== QFV param.*
MU2_11 = 4500^2 (fixed)
1000.^2 < MU2_22 < 4000.^2
600.^2 < MU2_33 < 3000.^2
|MU2_23| < 2000.^2 *<=== QFV param.*
MD2_11 = 4500^2 (fixed)
2500.^2 < MD2_22 < 4000.^2
1000.^2 < MD2_33 < 3000.^2
|MD2_23| < 2000.^2 *<=== QFV param*
ML2_11 = 1500^2 (fixed)
ML2_22 = 1500^2 (fixed)
ML2_33 = 1500^2 (fixed)
ML2_23 = 0. (fixed)

ME2_11 = 1500^2 (fixed)
ME2_22 = 1500^2 (fixed)
ME2_33 = 1500^2 (fixed)
ME2_23 = 0. (fixed)
|TU_23| < 4000 <=== QFV param
|TU_32| < 4000 <=== QFV param
|TU_33| < 5000 <=== QFC param
|TD_23| < 3000 <=== QFV param
|TD_32| < 3000 <=== QFV param
|TD_33| < 4000 <=== QFC param
TE_23 = 0. (fixed)
TE_32 = 0. (fixed)
|TE_33| < 500

- In the parameter scan, all of the relevant experimental and theoretical constraints are imposed.

- 8660000 parameter points are generated and 72904 points survive the constraints.

5. WC's $C_7(\mu_b)$ and $C'_7(\mu_b)$ in the MSSM with QFV

Low-energy effective Hamiltonian, at the bottom mass scale μ_b:

$$\mathcal{H}_{eff} = -\frac{4G_F}{\sqrt{2}} V_{tb} V_{ts}^* \sum_i C_i(\mu_b) Q_i(\mu_b) \,.$$

$$Q_2 = \bar{s}_L \gamma_\mu c_L \bar{c}_L \gamma^\mu b_L \,,$$

C_7

$$Q_7 = \frac{e}{16\pi^2} m_b \bar{s}_L \sigma^{\mu\nu} b_R F_{\mu\nu} \,,$$

C_8

$$Q_8 = \frac{g_s}{16\pi^2} m_b \bar{s}_L \sigma^{\mu\nu} G^a_{\mu\nu} T_a b_R \,.$$

$$Q'_2 = \bar{s}_R \gamma_\mu c_R \bar{c}_R \gamma^\mu b_R \,,$$

C'_7

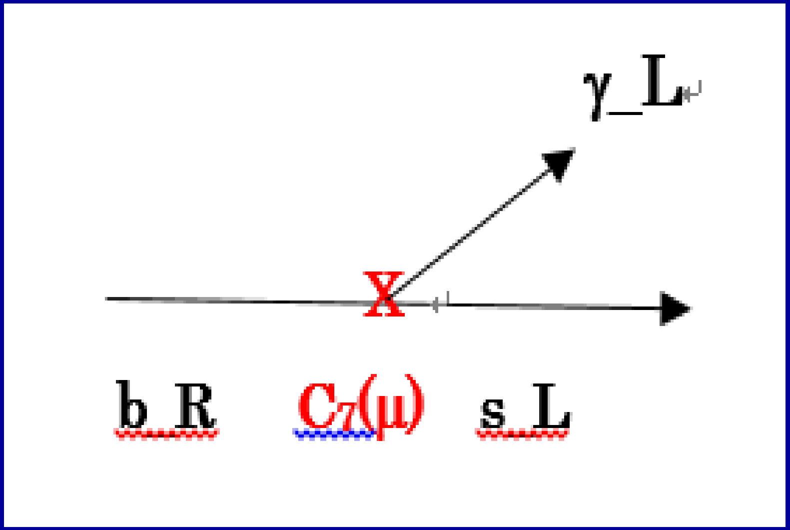
$$Q'_7 = \frac{e}{16\pi^2} m_b \bar{s}_R \sigma^{\mu\nu} b_L F_{\mu\nu} \,,$$

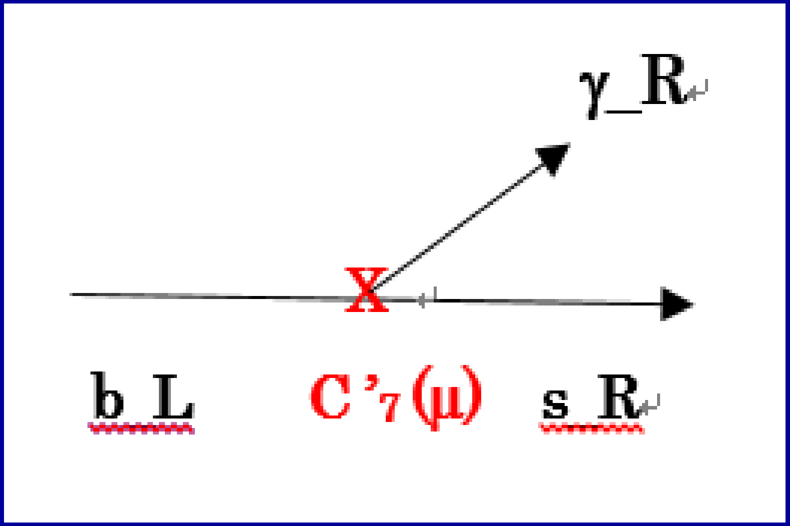
C'_8

$$Q'_8 = \frac{e}{16\pi^2} m_b \bar{s}_R \sigma^{\mu\nu} G^a_{\mu\nu} T_a b_L \,.$$

(Note) $C'_{7,8}(\mu) =\sim 0$ in SM

- *We compute the WC's $C_7(\mu_b)$ and $C'_7(\mu_b)$ at b quark mass scale μ_b at LO in the MSSM with QFV.*





- *The WC's $C_7(\mu_b)$ and $C'_7(\mu_b)$ can be measured precisely at BELLE II & LHCb-upgrade!*

We compute $\boldsymbol{C_{7,8}(\mu_W)}$ and $\boldsymbol{C'_{7,8}(\mu_W)}$ *at weak scale* μ_W *at LO in the MSSM with QFV.*

⇓

Then we compute $\boldsymbol{C_7(\mu_b)}$ ***and*** $\boldsymbol{C'_7(\mu_b)}$ ***at***

b quark mass scale $\boldsymbol{\mu_b}$

by using RGEs of QCD scale evolution.

RGE QCD scale evolution at LO:
$C_7(\mu_W) / C'_7(\mu_W) \rightarrow C_7(\mu_b) / C'_7(\mu_b)$
(μ_W = 160 GeV and μ_b = 4.8 GeV)

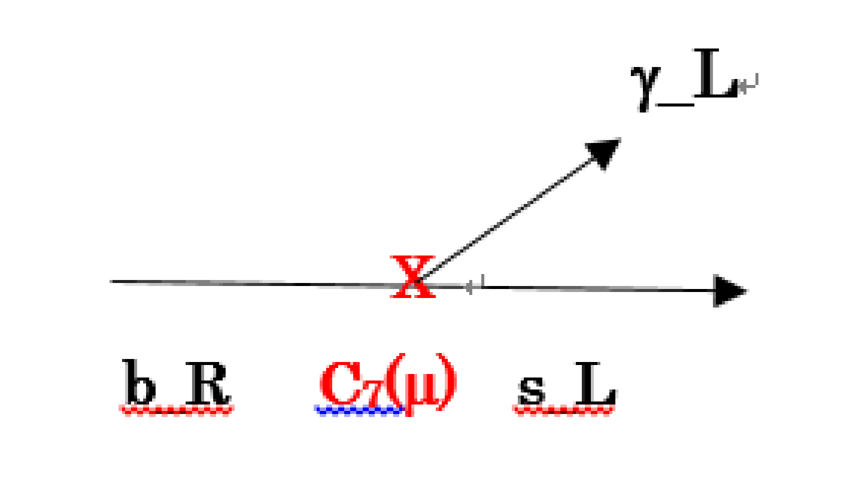
- $C_7(\mu_b) = \eta^{(16/23)} C_7(\mu_W) + (8/3)(\eta^{(14/23)} - \eta^{(16/23)}) C_8(\mu_W) + (\Sigma_{i=1-8} h_i \eta^{a_i})$
- $C'_7(\mu_b) = \eta^{(16/23)} C'_7(\mu_W) + (8/3)(\eta^{(14/23)} - \eta^{(16/23)}) C'_8(\mu_W)$

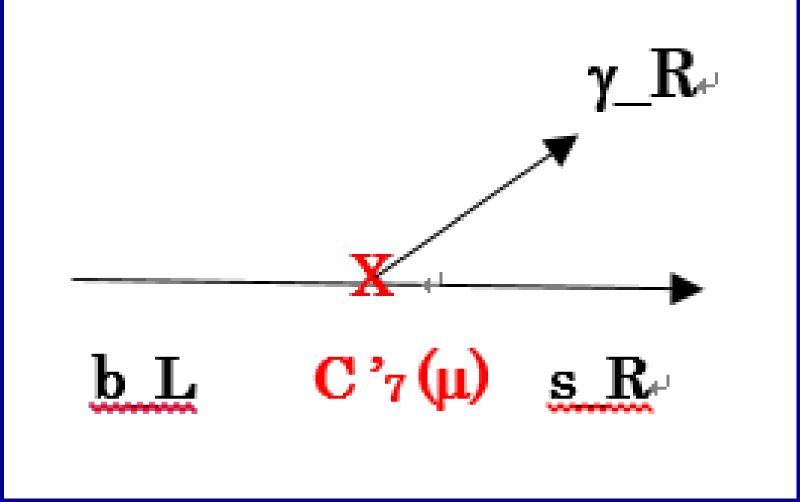
With

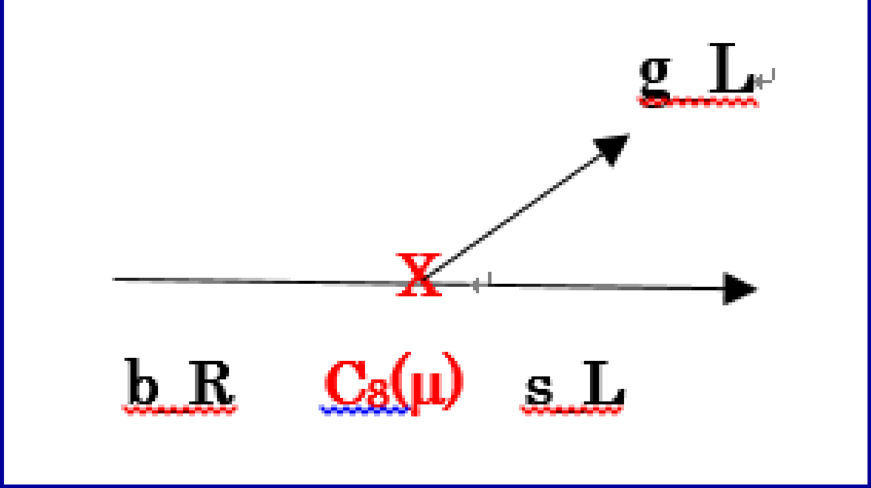
$\eta = \alpha_S(\mu_W)/\alpha_S(\mu_b)$

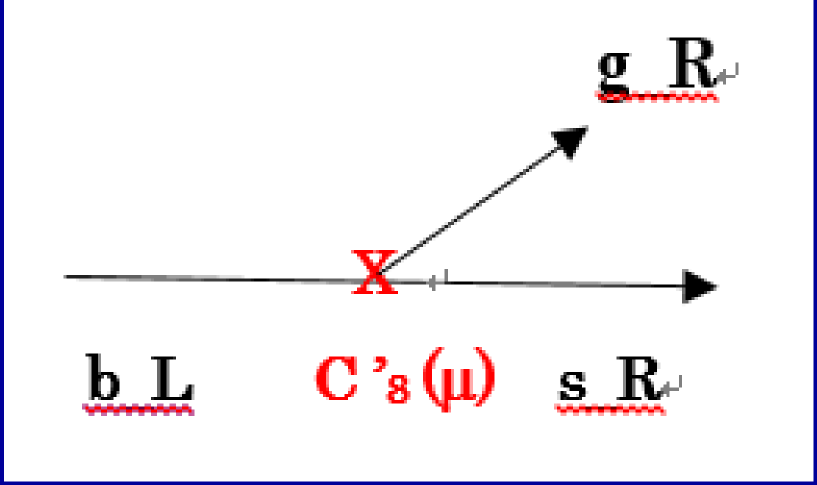
h_i = (626126/272277, -56281/51730, -3/7, -1/14, -0.6494, -0.0380, -0.0186, -0.0057)

a_i = (14/23, 16/23, 6/23, -12/23, 0.4086, -0.4230, -0.8994, 0.1456)

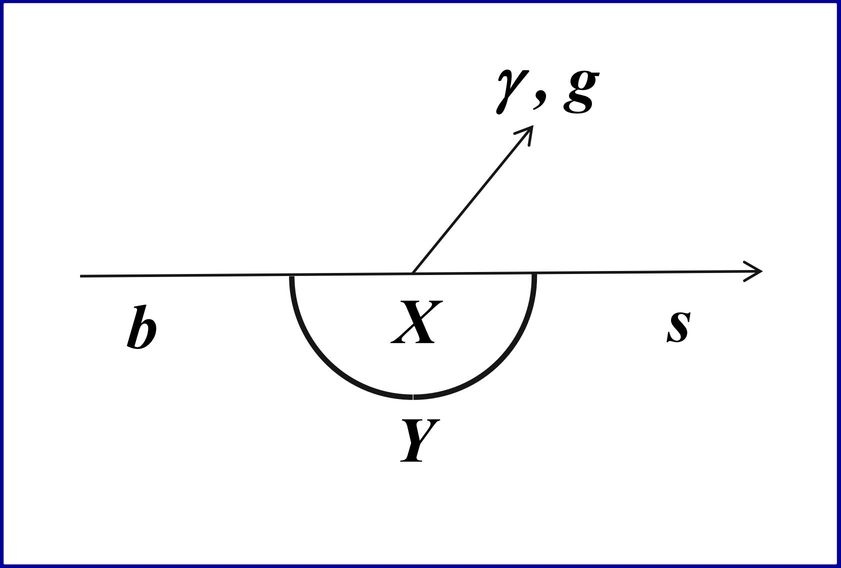

γ_L
b_R
$C_7(\mu)$
s_L


γ_R
b_L
$C'_7(\mu)$
s_R


g_L
b_R
$C_8(\mu)$
s_L


g_R
b_L
$C'_8(\mu)$
s_R

1-Loop contributions to $C_{7,8}(\mu_W)$ and $C'_{7,8}(\mu_W)$ at weak scale μ_W =160 GeV



SM one-loop contributions:

$(X,Y) = (t/c/u, W^+)$

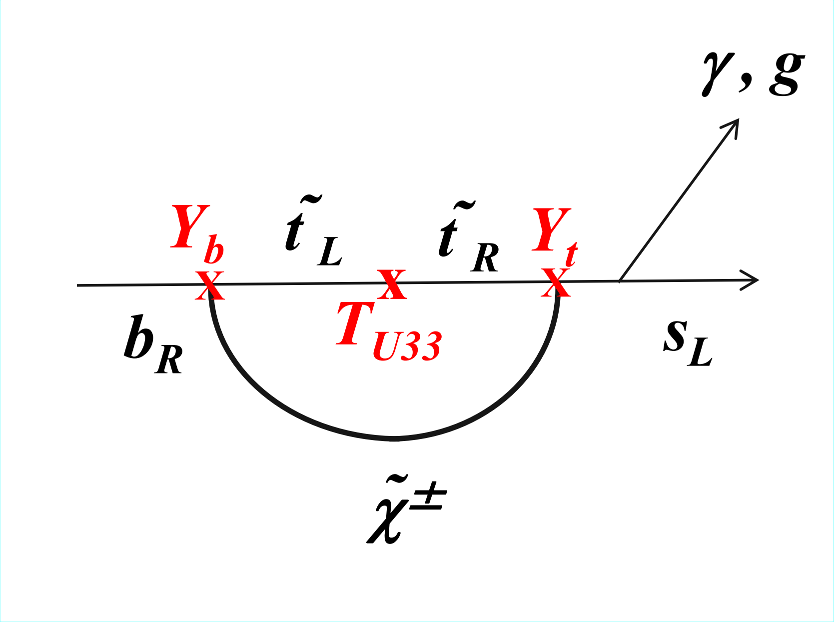
MSSM one-loop contributions:

(X,Y) = (stop/scharm, chargino),
(sbottom/sstrange, gluino),
(sbottom/sstrange, neutralino),
$(t/c/u, H^+)$

$\tilde{t}$ - $\tilde{t}$ loop contributions to $C_{7,8}(\mu_W)$:

$\tilde{\chi}^{\pm} \sim \tilde{W}^{\pm} + \tilde{H}^{\pm}$

Y_b : bottom Yukawa

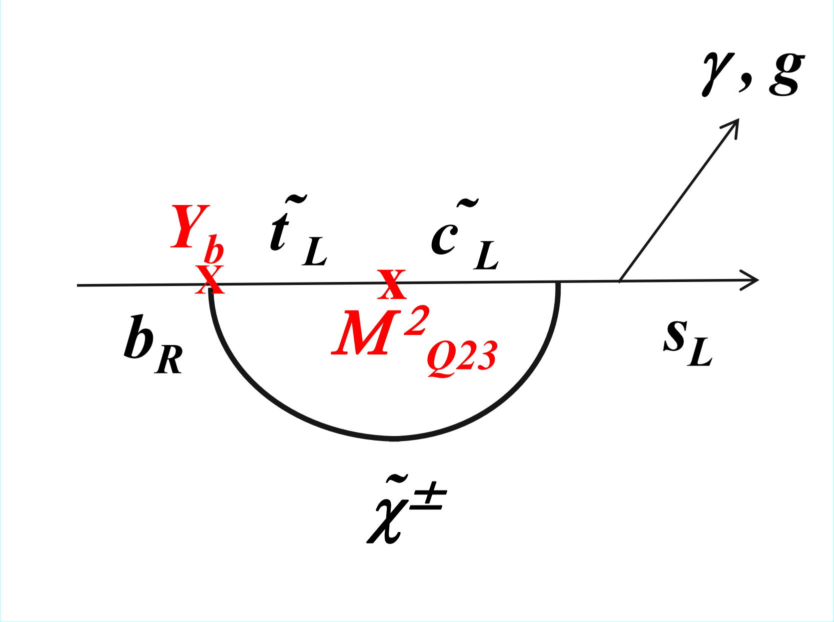


$\tilde{t}$ - $\tilde{t}$ loop contributions to $C_{7,8}(\mu_W)$ can be enhanced by large trilinear couplings T_{U33} and large Y_b for large $\tan\beta$ and large Y_t!

$\tilde{t}$ - $\tilde{c}$ loop contributions to $C_{7,8}(\mu_W)$:

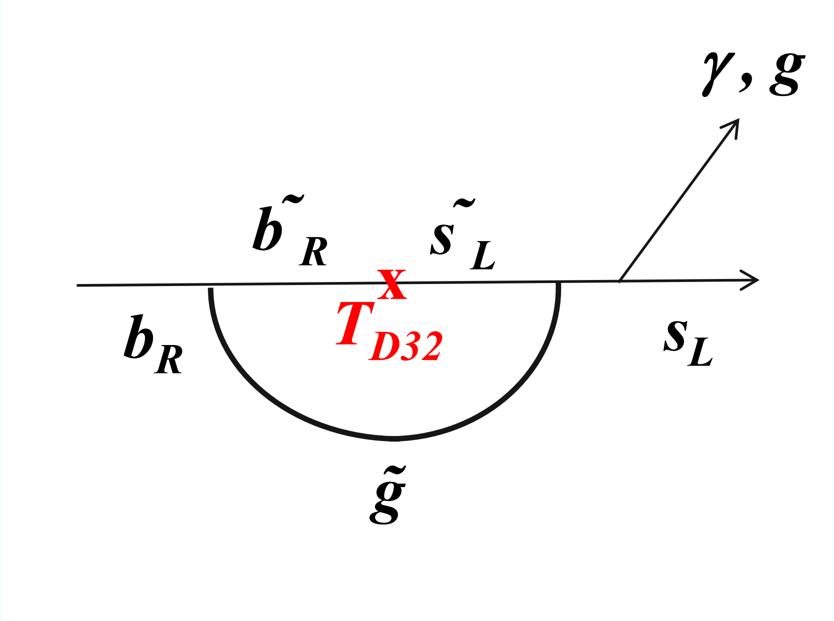
$\tilde{\chi}^{\pm} \sim \tilde{W}^{\pm} + \tilde{H}^{\pm}$

Y_b : bottom Yukawa



$\tilde{t}$ - $\tilde{c}$ loop contributions to $C_{7,8}(\mu_W)$ can be enhanced by large M^2_{Q23} being $\tilde{c}_L - \tilde{t}_L$ mixing term and large Y_b for large $\tan\beta$!

$\tilde{b}/\tilde{s}$ - $\tilde{g}$ loop contributions to $C_{7,8}(\mu_W)$:

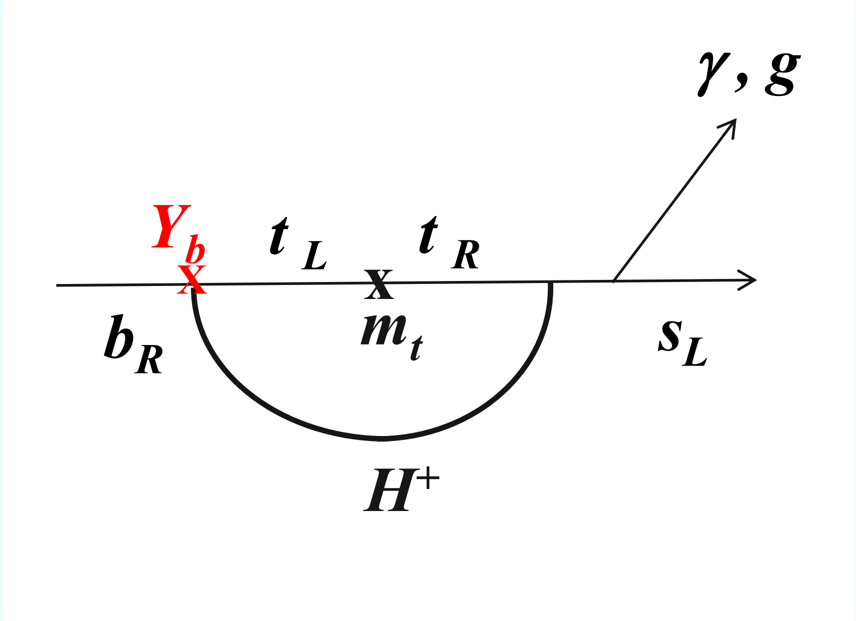


$|T_{D32}|$ is controlled by Y_b due to vacuum stability condition.

$\tilde{b}/\tilde{s}$ - $\tilde{g}$ loop contributions to $C_{7,8}(\mu_W)$ can be enhanced by large trilinear coupling T_{D32} and large Y_b for large $\tan\beta$!

Similarly, $\tilde{b}/\tilde{s} - \tilde{\chi}^0$ loop contributions to $C_{7,8}(\mu_W)$ can be enhanced by large trilinear coupling T_{D32}, M^2_{Q23} and large Y_b for large $\tan\beta$!

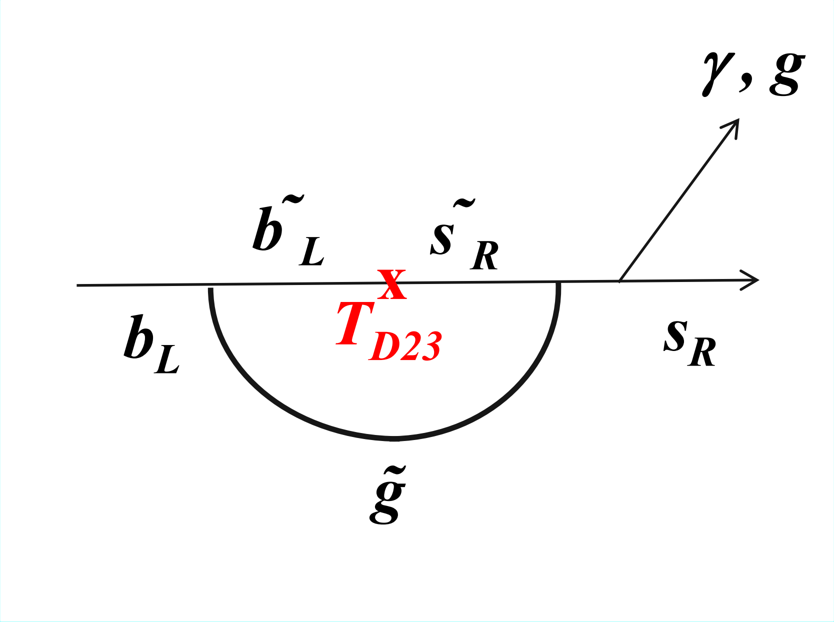
$t - H^+$ loop contributions to $C_{7,8}(\mu_W)$:



Y_b : bottom Yukawa coupling

$t - H^+$ loop contributions to $C_{7,8}(\mu_W)$ can be enhanced by large Y_b for large $\tan\beta$!

$\tilde{b}/\tilde{s}$ - $\tilde{g}$ loop contributions to $C'_{7,8}(\mu_W)$:



$|T_{D23}|$ is controlled by Y_b due to vacuum stability condition.

$\tilde{b}/\tilde{s}$ - $\tilde{g}$ loop contributions to $C'_{7,8}(\mu_W)$ can be enhanced by large trilinear coupling T_{D23} and large Y_b for large $\tan\beta$!

Similarly, $\tilde{b}/\tilde{s} - \tilde{\chi}^0$ loop contributions to $C'_{7,8}(\mu_W)$ can be enhanced by large trilinear coupling T_{D23}, M^2_{D23} and large Y_b for large tanβ!

- *large trilinear couplings* T_{U23} & T_{U32} & T_{U33} & T_{D23} & T_{D32}
- *large* Y_b *for large* $\tan\beta$

↓

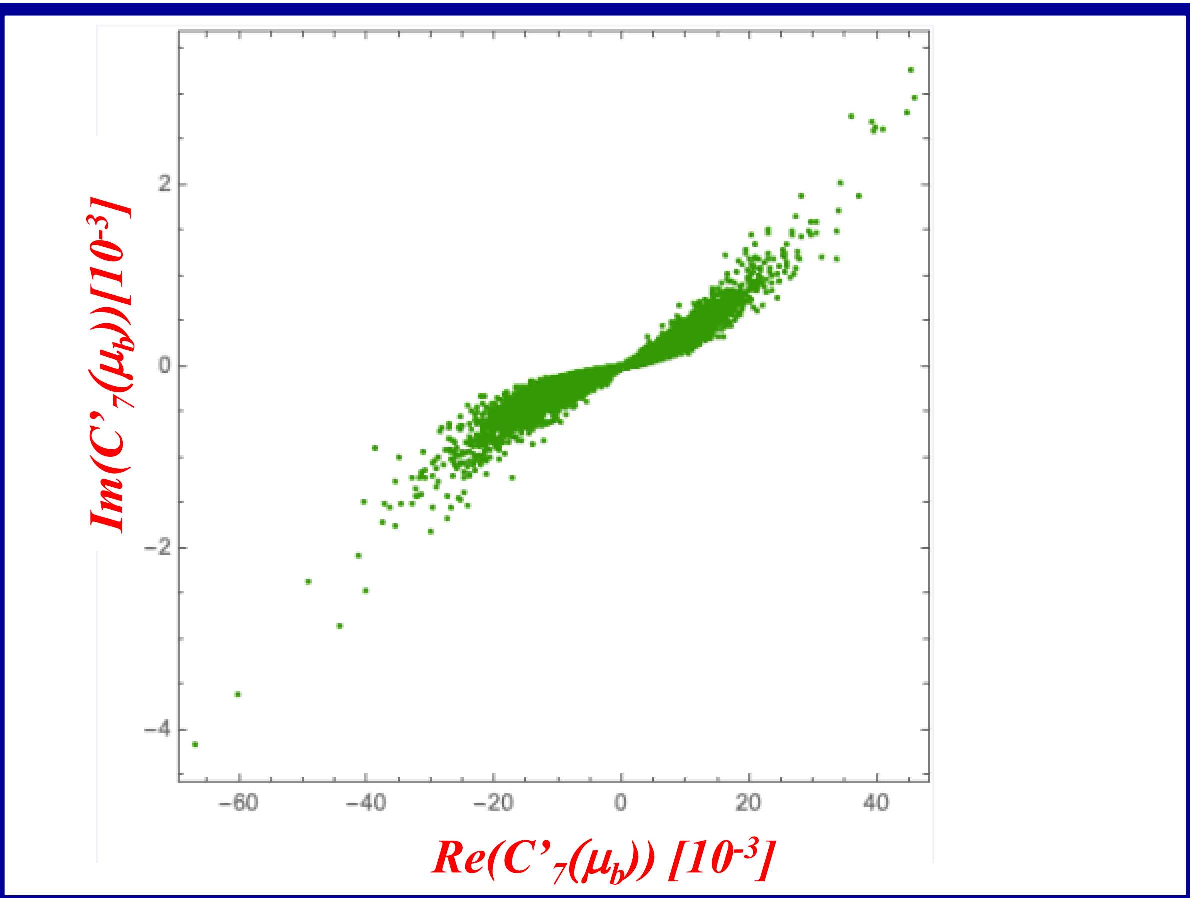
Large MSSM one-loop contributions to $C_{7,8}(\mu_W)$ ***and*** $C'_{7,8}(\mu_W)$ ***at weak scale*** μ_W ***!***

↓

Large MSSM one-loop contributions to $C_7(\mu_b)$ ***and*** $C'_7(\mu_b)$ ***at b quark mass scale*** μ_b ***!***

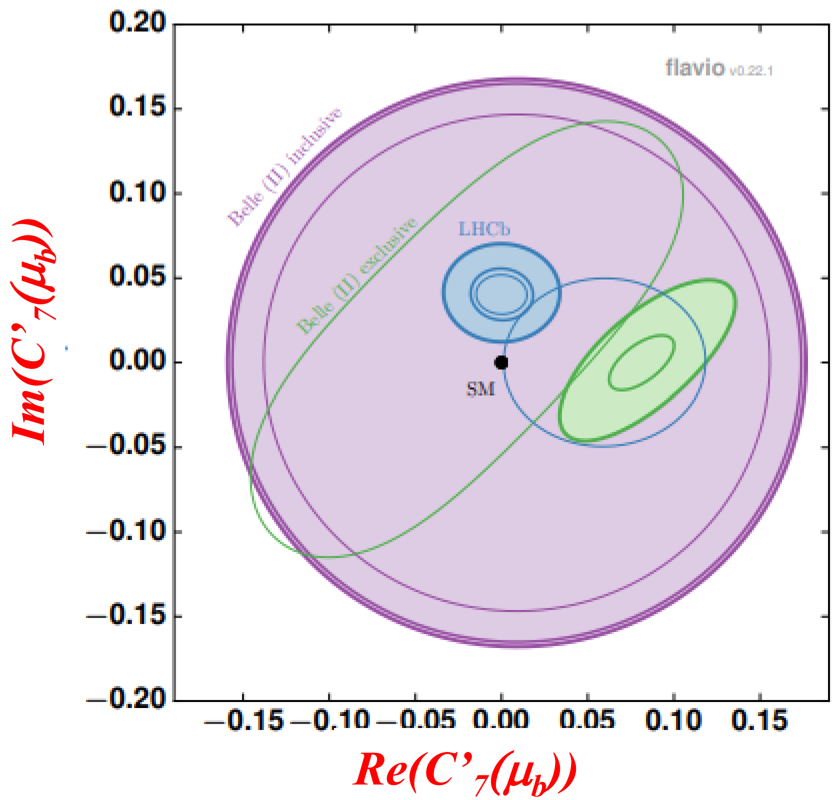
Of course, we can consider higher order MI contributions to the WC's $C_{7,8}$ ***&*** $C'_{7,8}$***. In this case, MI's of*** T_{U33}, T_{D33}, M^2_{Q23}, M^2_{U23} ***and*** M^2_{D23} ***can also contribute to the WC's, which can result in enhancement of the WC's by large*** $\{T_{U33}, T_{D33}, M^2_{Q23}, M^2_{U23}$ ***and*** $M^2_{D23}\}$***!***

Scatter Plot in $ReC'_7(\mu_b)$-$ImC'_7(\mu_b)$ plane



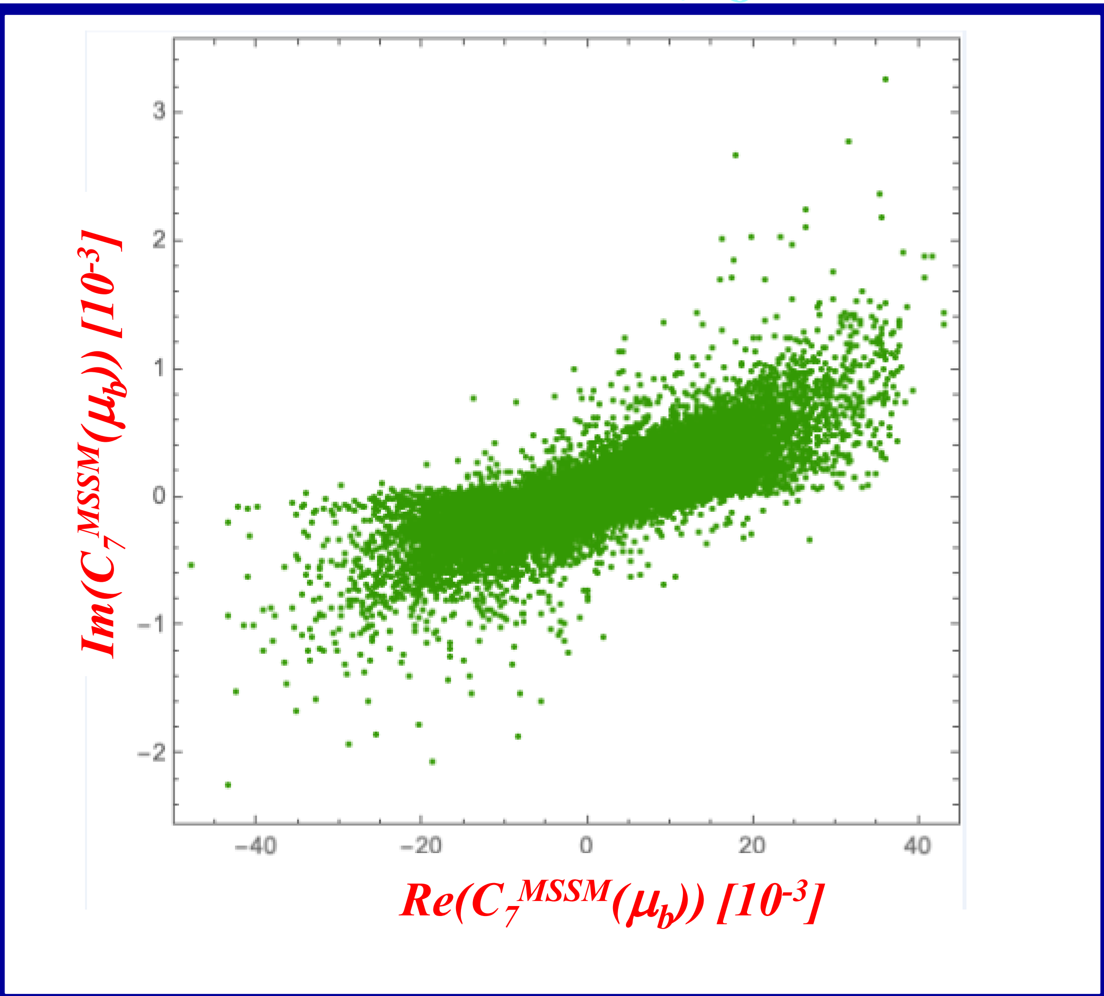
- *The MSSM contribution to $Re(C'_7(\mu_b))$ can be as large as ~ +0.05 & -0.07 which could correspond to about 4 sigma NP signal significance in future LHCb upgrade and Belle II experiments. (-> See next slide!)*

Expected errors of $ReC'_7(\mu_b)$-$ImC'_7(\mu_b)$ data from future LHCb-upgrade and BELLE II



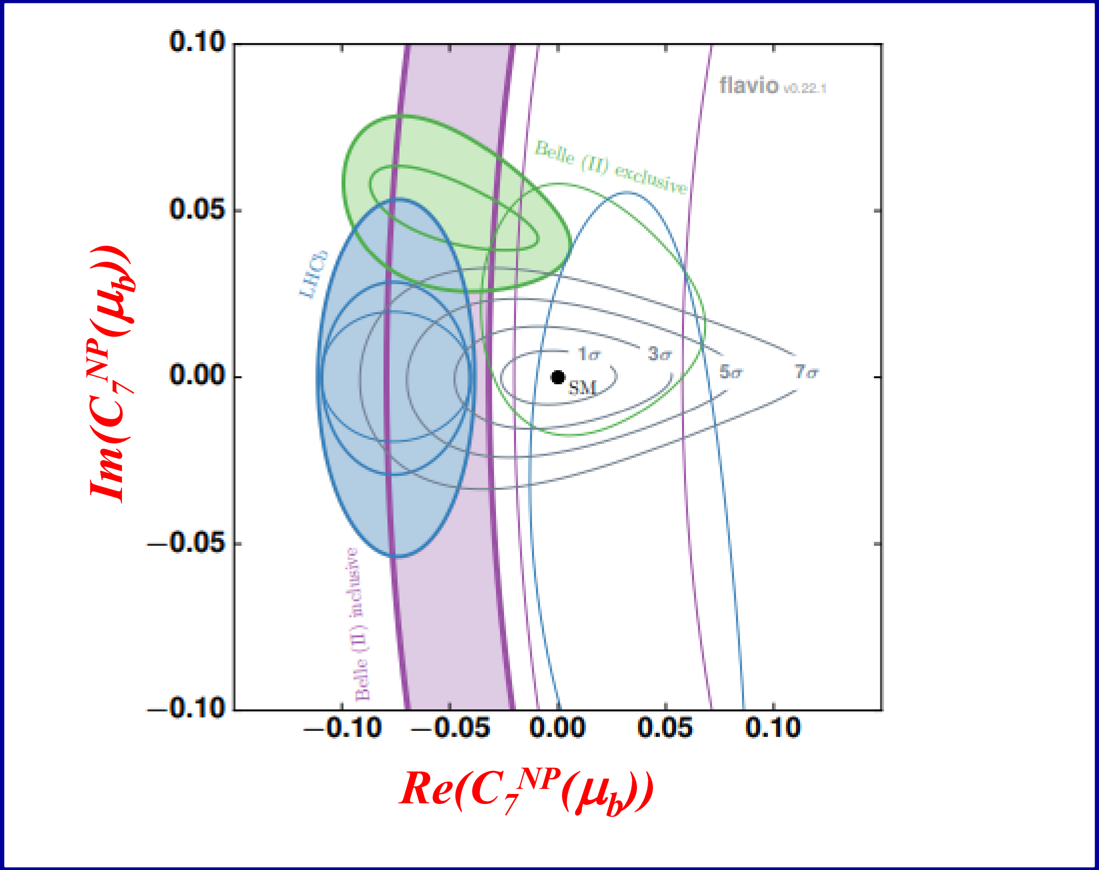
Belle II Physics Book, arXiv:1808.10567;
LHCb II Physics Book, arXiv:1808.08865;
Albrecht et al., arXiv:1709.10308.

Scatter Plot in $ReC_7^{MSSM}(\mu_b)$-$ImC_7^{MSSM}(\mu_b)$ plane



- *The MSSM contribution to $Re(C_7(\mu_b))$ can be as large as ~ +/-0.05 which could correspond to more than 3 sigma NP signal significance in future LHCb-upgrade and Belle II experiments.* *(-> See next slide!)*

Expected errors of $ReC_7^{NP}(\mu_b)$-$ImC_7^{NP}(\mu_b)$ data from future LHCb-upgrade and BELLE II



Belle II Physics Book, arXiv:1808.10567;
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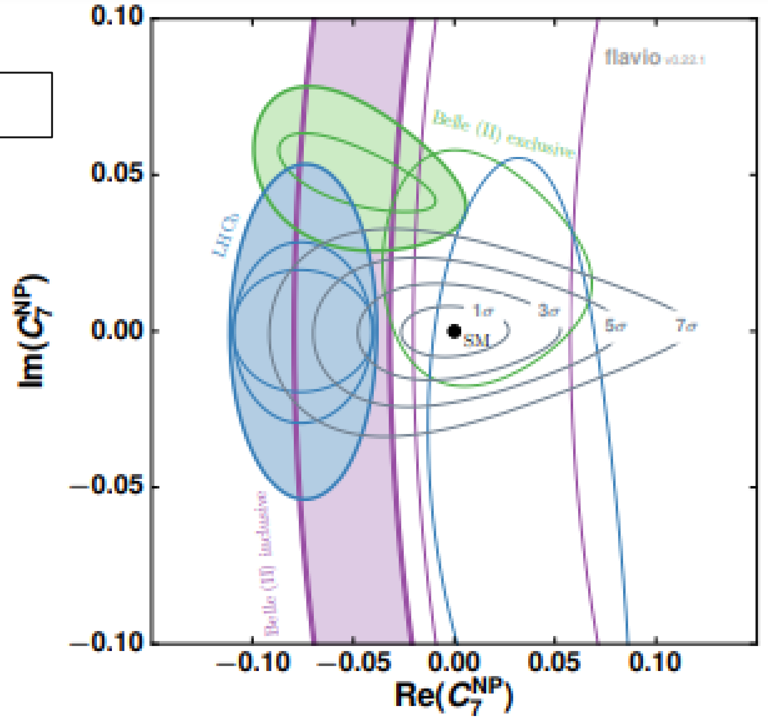
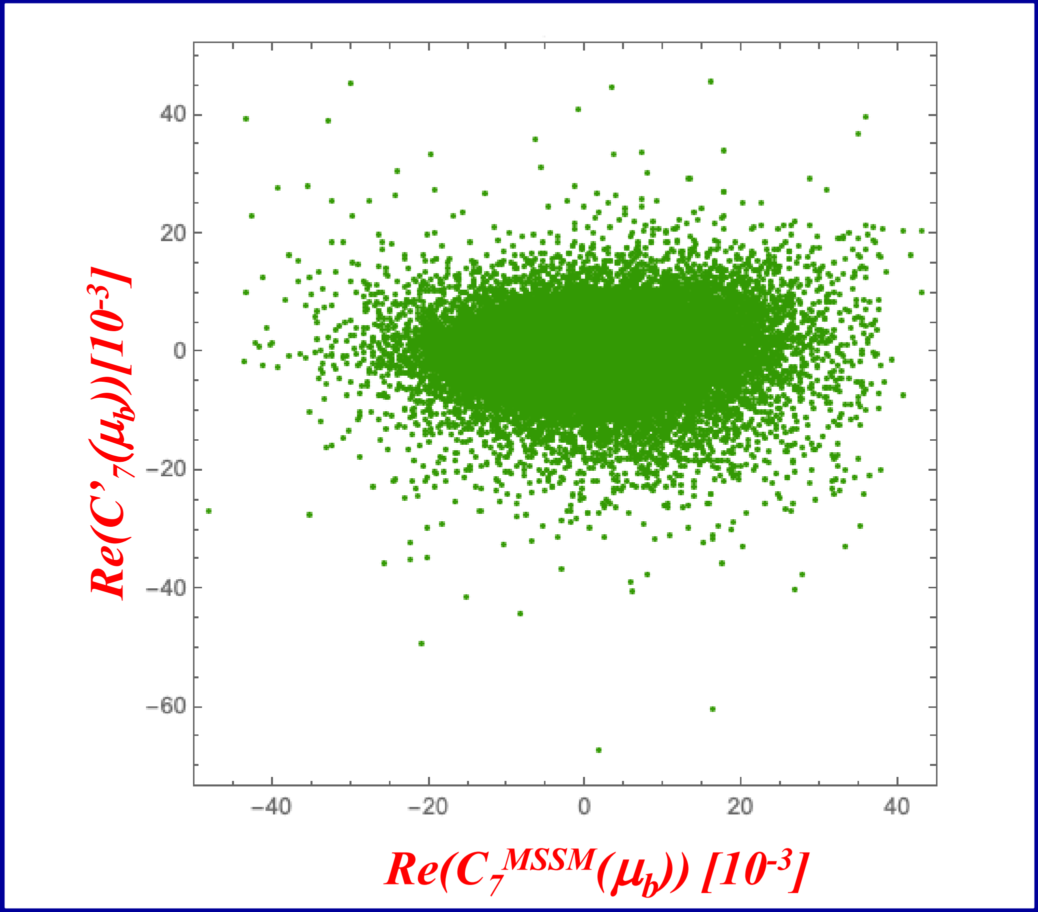


(c) $\mathcal{R}e\left(C_7^{\text{NP}}\right)$ versus $\mathcal{I}m\left(C_7^{\text{NP}}\right)$.

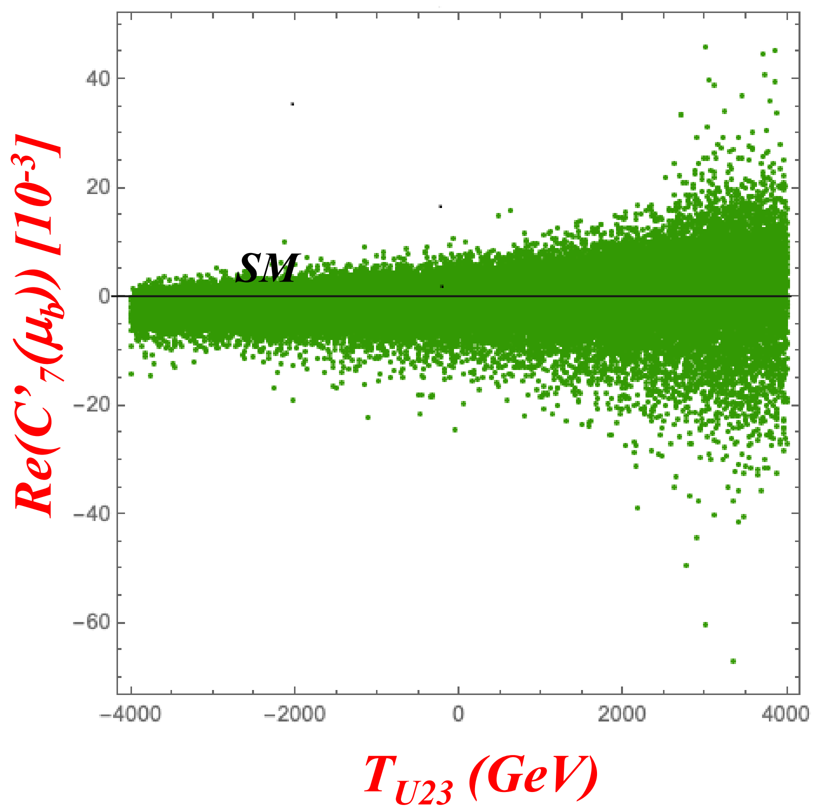
Figure 8: In the two-dimensional scans of pairs of Wilson coefficients, the current average (not filled) as well as the extrapolations to future sensitivities (filled) of LHCb at milestones I, II and III (exclusive) and Belle II at milestones I and II (inclusive and exclusive) are given. The central values of the extrapolations have been evaluated in the NP scenarios listed in Table 5. The contours correspond to 1σ uncertainty bands. The Standard Model point (black dot) with the $1\sigma, 3\sigma$, 5σ and 7σ exclusion contours with a combined sensitivity of LHCb's $50\,\text{fb}^{-1}$ and Belle II's $50\,\text{ab}^{-1}$ datasets is indicated in light grey. The primed operators show no tensions with respect to the SM; hence no SM exclusions are provided.

Scatter plot in $Re(C_7^{MSSM}(\mu_b)) - Re(C'_7(\mu_b))$ plane



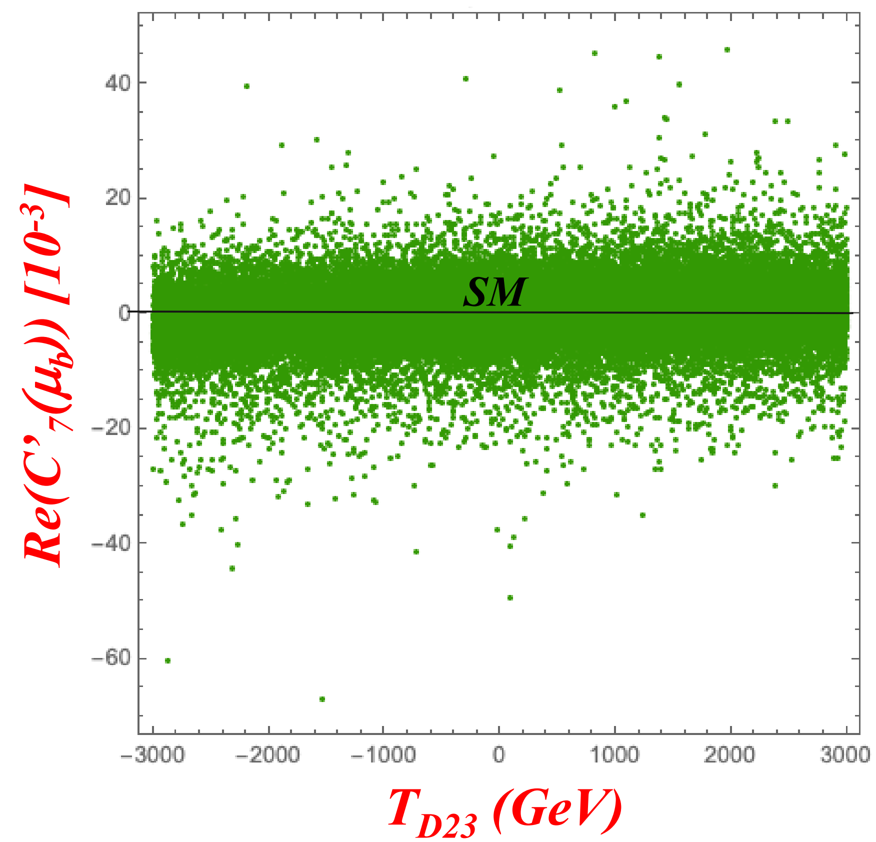
- $Re(C_7^{MSSM}(\mu_b))$ and $Re(C'_7(\mu_b))$ can be quite sizable simultaneously!

Scatter plot in $T_{U23} – Re(C'_7(\mu_b))$ plane



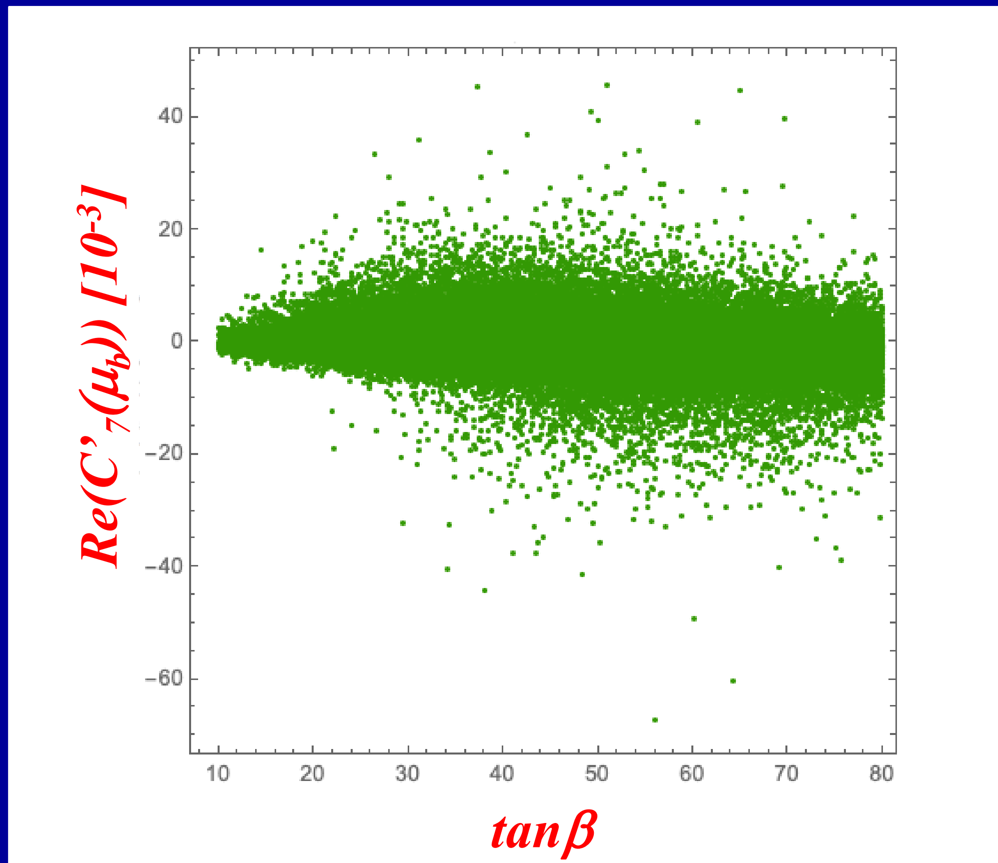
- *MSSM one-loop contributions to $Re(C'_7(\mu_b))$ can be large (~ +0.05 & -0.07) for large $T_{U23} > 0$!*
- *$Re(C'_7(\mu_b))$ =~ 0 (SM)*

Scatter plot in $T_{D23} - Re(C'_7(\mu_b))$ plane



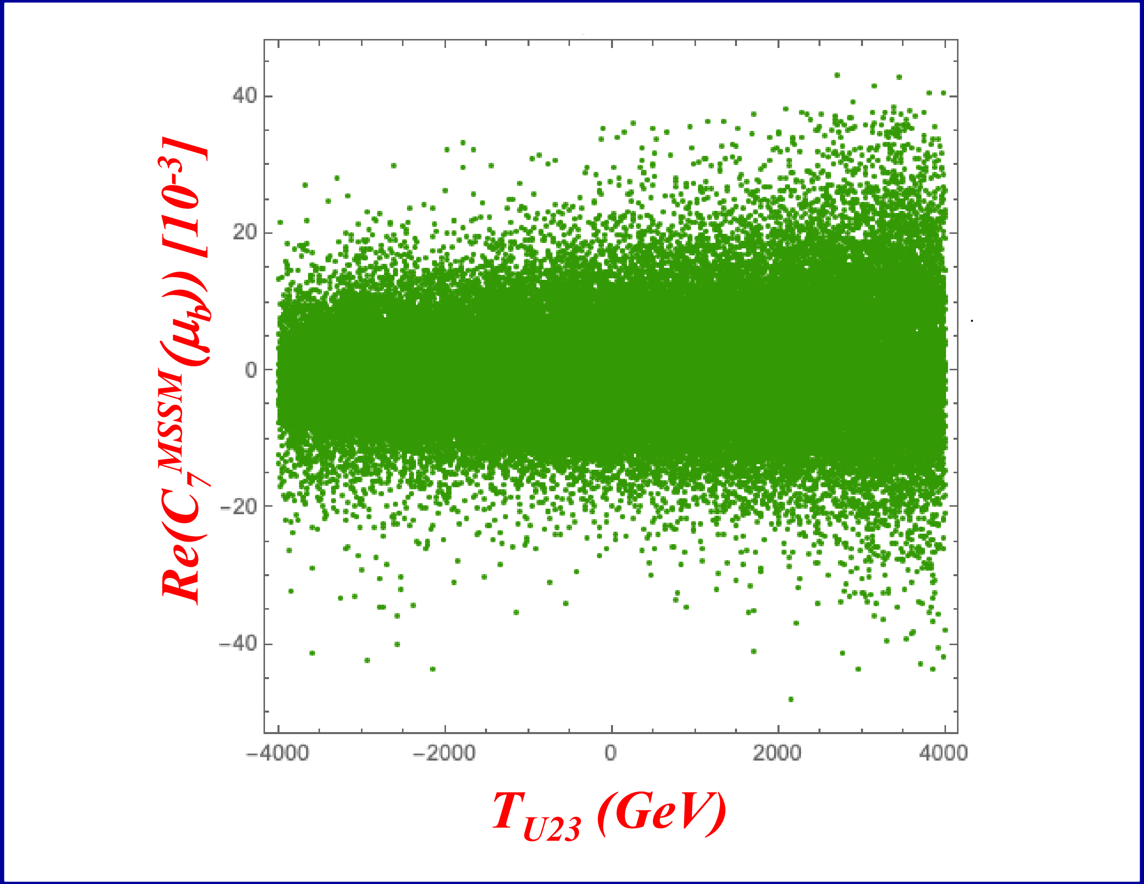
- MSSM one-loop contributions to $Re(C'_7(\mu_b))$ can be large (~ +0.05 & -0.07) for large $|T_{D23}|$!
- $Re(C'_7(\mu_b)) =\sim 0$ (SM)

Scatter plot in tanβ–Re($C'_7(\mu_b)$) plane



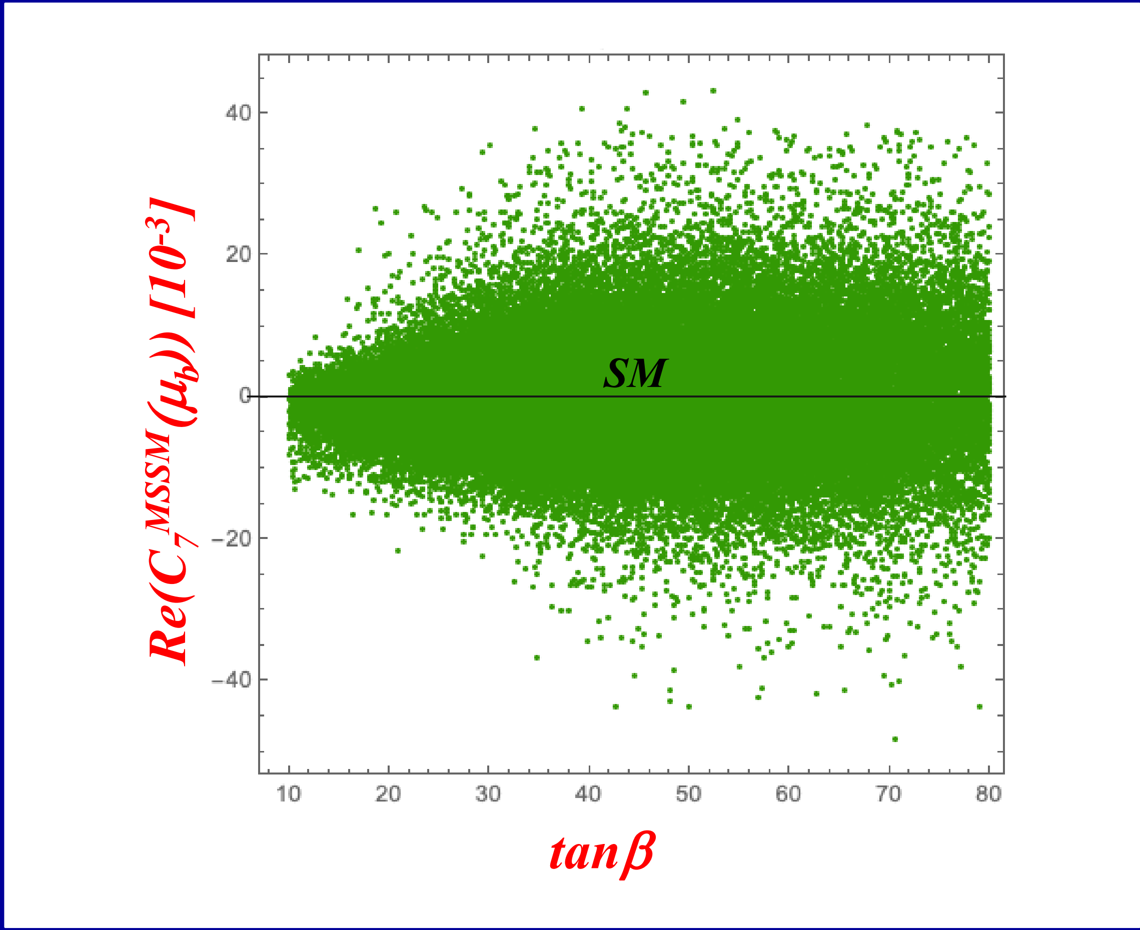
- *MSSM one-loop contributions to Re($C'_7(\mu_b)$) can be large (~ +0.05 & -0.07) for large tanβ !*
- *Re($C'_7(\mu_b)$) =~ 0 (SM)*

Scatter plot in $T_{U23} - Re(C_7^{MSSM}(\mu_b))$ plane



- MSSM one-loop contributions to $Re(C_7(\mu_b))$ can be large (~ +/-0.05) for large $T_{U23} > 0$!

Scatter plot in $\tan\beta$ – $Re(C_7^{MSSM}(\mu_b))$ plane



- *MSSM one-loop contributions to $Re(C_7(\mu_b))$ can be large (~ +/-0.05) for $\tan\beta$!*

6. Conclusion

- *We have studied SUSY effects on $C_7(\mu_b)$ and $C'_7(\mu_b)$ which are the Wilson coefficients for b -> s gamma at b quark mass scale μ_b and are closely related to radiative B meson decays.*

- *The SUSY-loop contributions to the $C_7(\mu_b)$ and $C'_7(\mu_b)$ are calculated at LO in the MSSM with general quark flavor violation (QFV) with real parameters.*

- *In the computation of the WC's, we have performed a MSSM parameter scan respecting theoretical constraints from vacuum stability conditions and experimental constraints, such as those from K- & B-meson data and electroweak precision data, as well as recent limits on SUSY particle masses and the 125GeV Higgs boson data from LHC experiments.*

- *From the parameter scan, we have found the following:*

  (1) The MSSM contribution to Re($C_7(\mu_b)$) can be as large as ~ +/-0.05 which could correspond to about 3 sigma NP (New Physics) signal significance in future LHCb-upgrade and Belle II experiments.

  (2) The MSSM contribution to Re($C'_7(\mu_b)$) can be as large as ~ +0.05 & -0.07 which could correspond to about 4 sigma NP signal significance in future LHCb-upgrade and Belle II experiments.

  (3) These large MSSM contributions to the WC's are mainly due to
  - *large $\tilde{c}$ - $\tilde{t}$ mixing & large $\tilde{c}$ / $\tilde{t}$ trilinear couplings T_{U32}, T_{U23}, T_{U33},*
  - *large $\tilde{s}$ - $\tilde{b}$ mixing & large $\tilde{s}$ / $\tilde{b}$ trilinear couplings T_{D32}, T_{D23}, T_{D33},*
  - *large Y_b for large $\tan\beta$,*

- *It is very important to reduce the (theoretical and experimental) errors of the WC's $C_7^{NP}(\mu_b)$ & $C'_7(\mu_b)$ data obtained from the future experiments at Belle II and the LHCb upgrade.*
  An improvement in precision of both theory and experiment by a factor about 1.5 or so would be very important in view of NP search (such as SUSY search).
  Therefore, we strongly encourage theoretists and experimentalists to challenge this task.

- *In case such large NP contributions to the WC's are really observed in the future experiments at Belle II and LHCb upgrade, it could suggest the discovery of QFV SUSY (MSSM with general QFV) and would encourage to perform further studies of the WC's $C'_7(\mu_b)$ and $C_7^{MSSM}(\mu_b)$ at NLO/NNLO level in this model.*

- *Our analysis suggests the following:*

  PETRA/TRISTAN e- e+ collider discovered virtual Z^0 effect for the first time.

  Later, CERN p pbar collider discovered the Z^0 boson.

  Similarly, BELLE II / LHCb upgrade could discover virtual Sparticle effects for the first time in radiative

  B meson decays!

  Later, FCC-hh p p collider could discover the Sparticles!

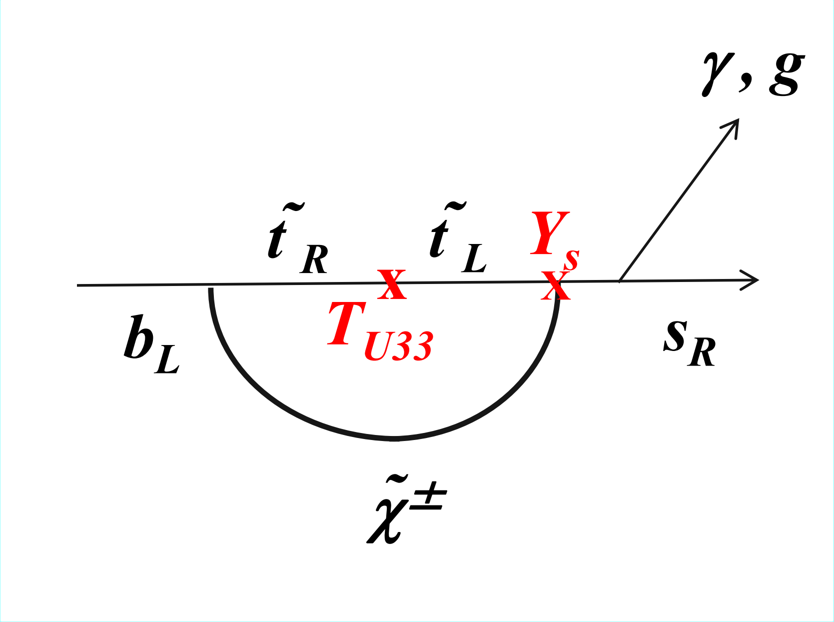
END

Thank you!

Backup Slides

$\tilde{t}$ - $\tilde{t}$ loop contributions to $C'_{7,8}(\mu_W)$:

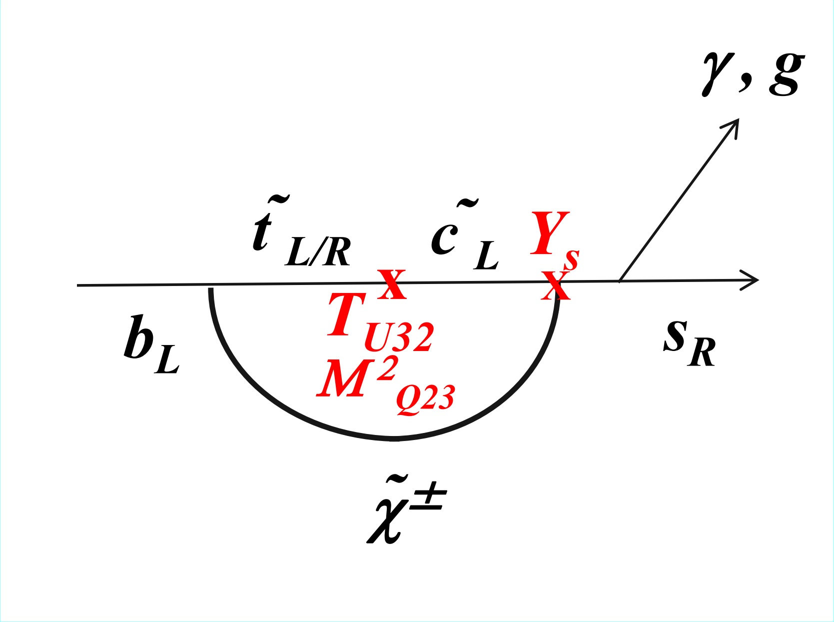
$\tilde{\chi}^{\pm} \sim \tilde{W}^{\pm} + \tilde{H}^{\pm}$



$\tilde{t}$ - $\tilde{t}$ loop contributions to $C'_{7,8}(\mu_W)$ should be small due to very small Y_s!

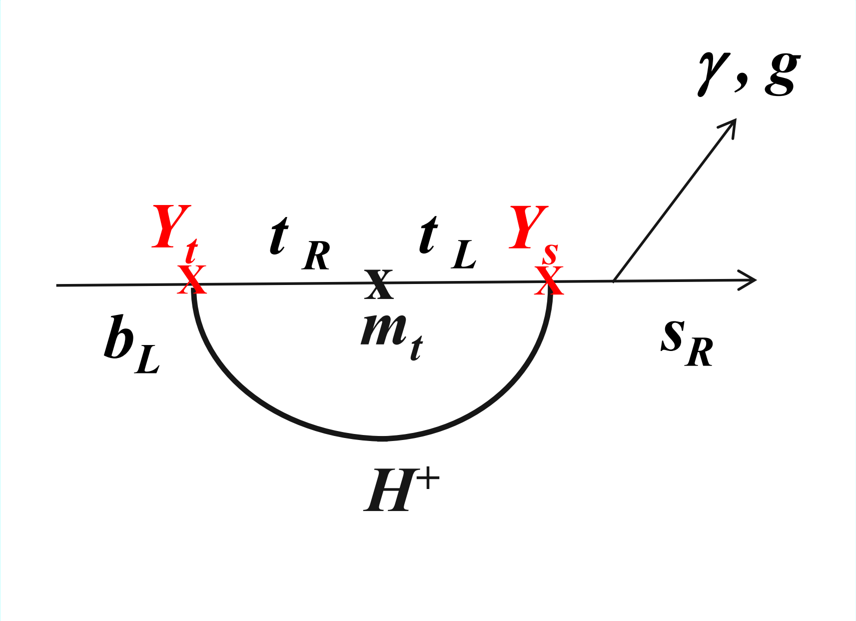
$\tilde{t}$ - $\tilde{c}$ loop contributions to $C'_{7,8}(\mu_W)$:

$\tilde{\chi}^{\pm} \sim \tilde{W}^{\pm} + \tilde{H}^{\pm}$



$\tilde{t}$ - $\tilde{c}$ loop contributions to $C'_{7,8}(\mu_W)$ should be small due to very small Y_s!

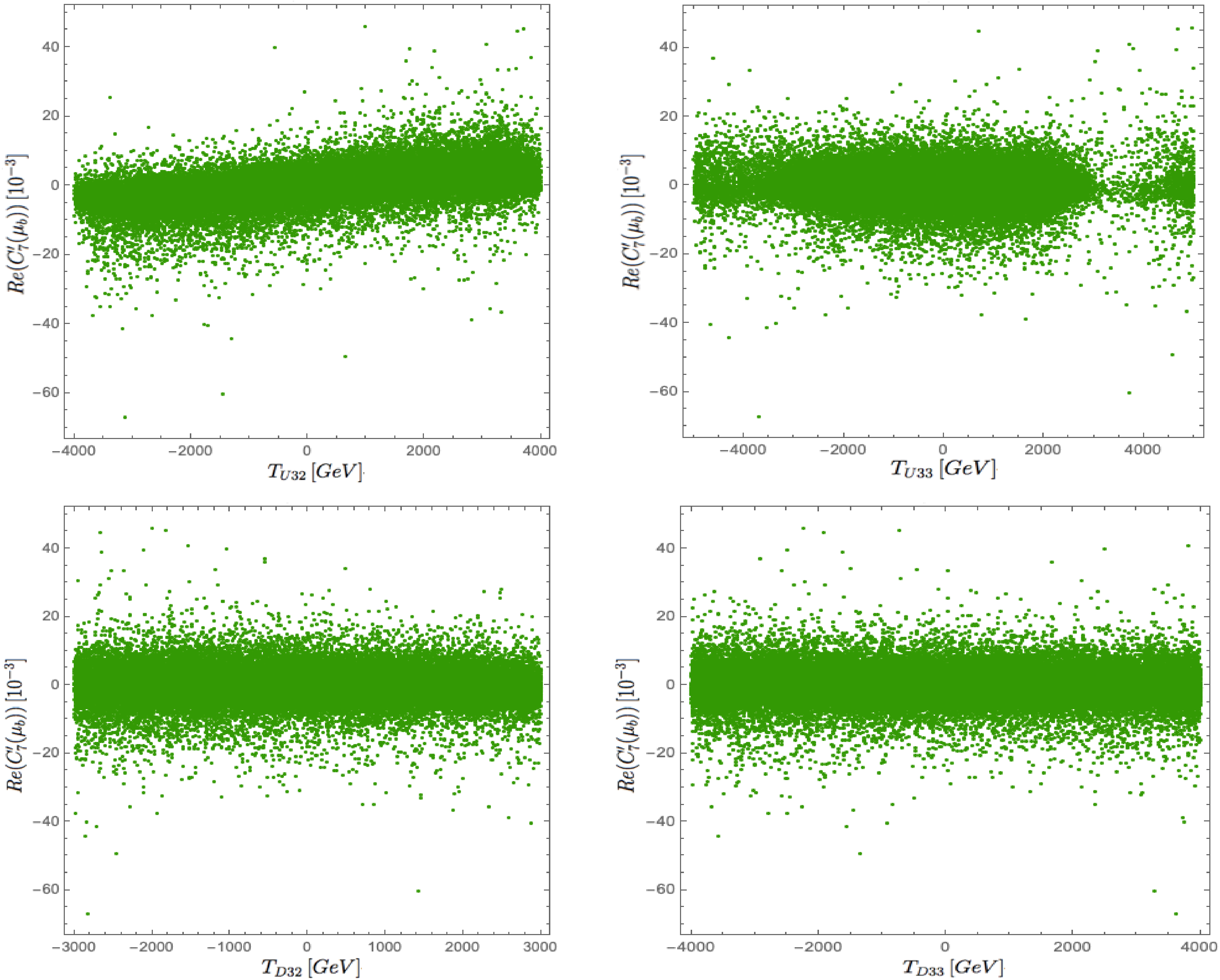
$t - H^+$ loop contributions to $C'_{7,8}(\mu_W)$:



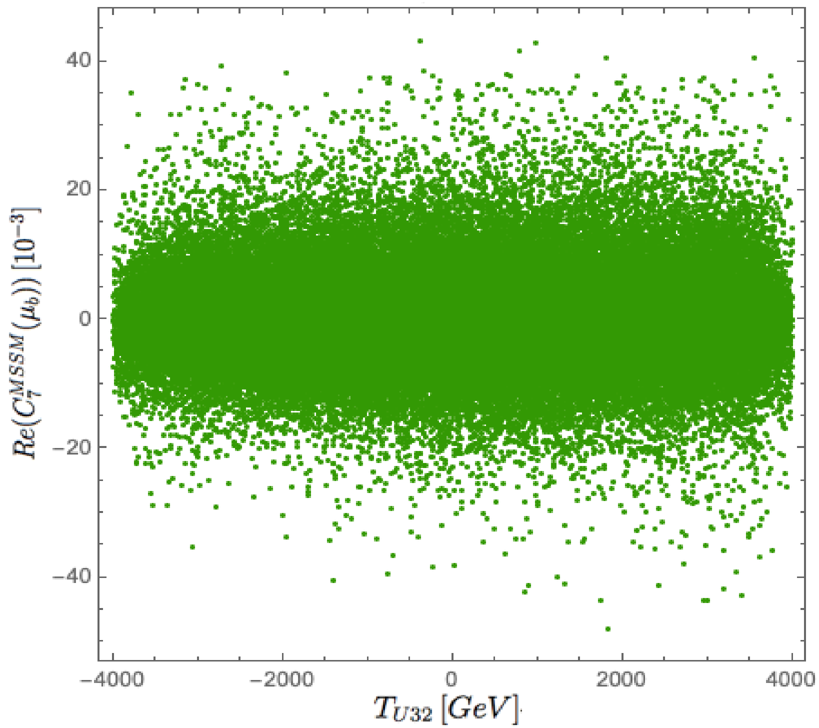
Y_t : top Yukawa coupling

Y_s : s quark Yukawa coupling

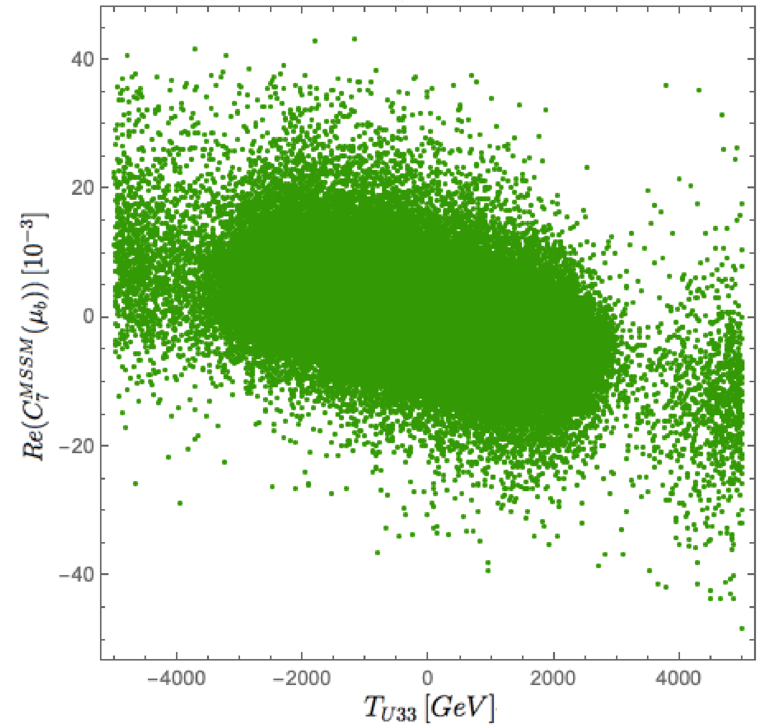
$t - H^+$ loop contributions to $C'_{7,8}(\mu_W)$ is small due to small Y_s.



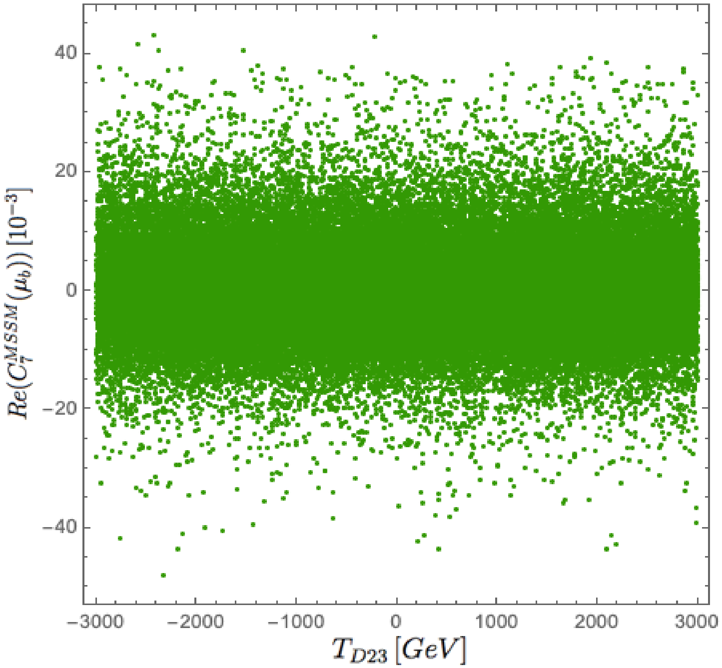
40
20
0
-20
-40
-60
$Re(C'_7(\mu_b))$ $[10^{-3}]$
-4000
-2000
0
2000
4000
T_{U32} $[GeV]$
T_{U33} $[GeV]$
-3000
-1000
1000
3000
T_{D32} $[GeV]$
T_{D33} $[GeV]$



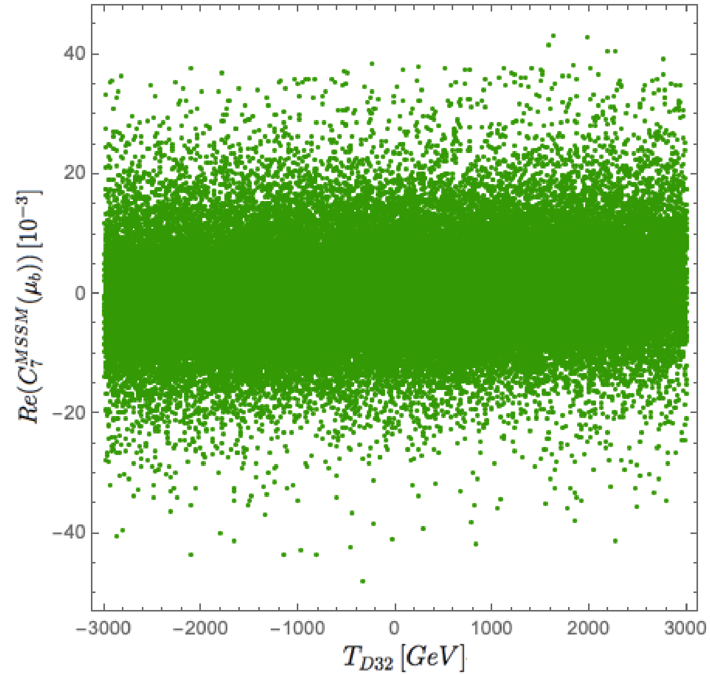
40
20
0
−20
−40
$Re(C_7^{MSSM}(\mu_b))\,[10^{-3}]$
−4000
−2000
0
2000
4000
$T_{U32}\,[GeV]$



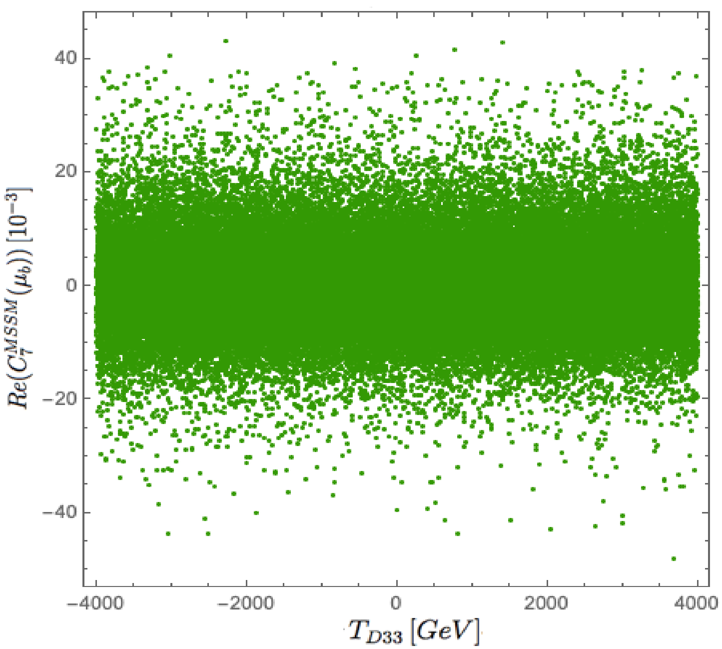
40
20
0
−20
−40
$Re(C_7^{MSSM}(\mu_b))\,[10^{-3}]$
−4000
−2000
0
2000
4000
$T_{U33}\,[GeV]$



$Re(C_7^{MSSM}(\mu_b))\,[10^{-3}]$
40
20
0
-20
-40
-3000
-2000
-1000
0
1000
2000
3000
$T_{D23}\,[GeV]$



$Re(C_7^{MSSM}(\mu_b))\,[10^{-3}]$
40
20
0
-20
-40
-3000
-2000
-1000
0
1000
2000
3000
$T_{D32}\,[GeV]$



$Re(C_7^{MSSM}(\mu_b))\,[10^{-3}]$
40
20
0
-20
-40
-4000
-2000
0
2000
4000
$T_{D33}\,[GeV]$

Constraints on the MSSM parameters from K & B meson and h^0 data:

Table 5: Constraints on the MSSM parameters from the K- and B-meson data relevant mainly for the mixing between the second and the third generations of squarks and from the data on the h^0 mass and coupling κ_b, κ_g, κ_γ. The fourth column shows constraints at 95% CL obtained by combining the experimental error quadratically with the theoretical uncertainty, except for $B(K_L^0 \to \pi^0 \nu\bar{\nu})$, m_{h^0} and $\kappa_{b,g,\gamma}$.

Observable	Exp. data	Theor. uncertainty	Constr. (95%CL)
$10^3 \times \lvert\epsilon_K\rvert$	2.228 ± 0.011 (68% CL) [30]	± 0.28 (68% CL) [41]	2.228 ± 0.549
$10^{15} \times \Delta M_K$ [GeV]	3.484 ± 0.006 (68% CL) [30]	± 1.2 (68% CL) [41]	3.484 ± 2.352
$10^9 \times \mathrm{B}(K_L^0 \to \pi^0 \nu\bar{\nu})$	< 3.0 (90% CL) [30]	± 0.002 (68% CL) [30]	< 3.0 (90% CL)
$10^{10} \times \mathrm{B}(K^+ \to \pi^+ \nu\bar{\nu})$	1.7 ± 1.1 (68% CL) [30]	± 0.04 (68% CL) [30]	$1.7^{+2.16}_{-1.70}$
ΔM_{B_s} [ps^{-1}]	17.757 ± 0.021 (68% CL) [30, 42]	± 2.7 (68% CL) [43]	17.757 ± 5.29
$10^4 \times \mathrm{B}(b \to s\gamma)$	3.32 ± 0.15 (68% CL) [30, 42]	± 0.23 (68% CL) [8]	3.32 ± 0.54
$10^6 \times \mathrm{B}(b \to s\ l^+ l^-)$ ($l = e$ or μ)	$1.60\ ^{+0.48}_{-0.45}$ (68% CL) [44]	± 0.11 (68% CL) [45]	$1.60\ ^{+0.97}_{-0.91}$
$10^9 \times \mathrm{B}(B_s \to \mu^+ \mu^-)$	$2.7\ ^{+0.5}_{-0.4}$ (68%CL) [46]	± 0.23 (68% CL) [47]	$2.70\ ^{+1.08}_{-0.90}$
$10^4 \times \mathrm{B}(B^+ \to \tau^+ \nu)$	1.06 ± 0.19 (68%CL) [42]	± 0.29 (68% CL) [48]	1.06 ± 0.69
m_{h^0} [GeV]	125.09 ± 0.24 (68% CL) [49]	± 3 [50]	125.09 ± 3.48
κ_b	$1.06^{+0.37}_{-0.35}$ (95% CL) [52]		$1.06^{+0.37}_{-0.35}$ (ATLAS)
	$1.17^{+0.53}_{-0.61}$ (95% CL) [53]		$1.17^{+0.53}_{-0.61}$ (CMS)
κ_g	$1.03^{+0.14}_{-0.12}$ (95% CL) [52]		$1.03^{+0.14}_{-0.12}$ (ATLAS)
	$1.18^{+0.31}_{-0.27}$ (95% CL) [53]		$1.18^{+0.31}_{-0.27}$ (CMS)
κ_γ	1.00 ± 0.12 (95% CL) [52]		1.00 ± 0.12 (ATLAS)
	$1.07^{+0.27}_{-0.29}$ (95% CL) [53]		$1.07^{+0.27}_{-0.29}$ (CMS)