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Using the $e^{\pm}\mu^{\mp} + E_T^{miss}$ signature in the search for supersymmetry and lepton flavour violation in neutralino decays

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Abstract

The LHC (CMS) discovery potential of the $e^{\pm}\mu^{\mp} + E_T^{miss}$ signature in the search for supersymmetry and lepton flavour violation in neutralino decays is studied. A detailed study is done for the CMS test points LM1-LM9. It is shown that for the point LM1 it is possible to detect lepton flavour violation in neutralino decays with lepton flavour violating branching $Br(\tilde{\chi}_2^0 \to \mu^{\pm}e^{\mp}\tilde{\chi}_1^0) \geq 0.04 Br(\tilde{\chi}_2^0 \to e^+e^-\tilde{\chi}_1^0, \mu^+\mu^-\tilde{\chi}_1^0)$ for an integral luminosity $10 fb^{-1}$. A discovery potential in the mSUGRA-SUSY scenario with $\tan\beta = 10,\ sign(\mu) = +$ in the $(m_0,\ m_{1/2})$ plane using the $e^{\pm}\mu^{\mp} + E_T^{miss}$ signature is determined.

1 Introduction

One of the goals of the Large Hadron Collider (LHC) [1] is the discovery of supersymmetry (SUSY). The squark and gluino decays produce missing transverse energy from lightest stable superparticle (LSP) plus multiple jets and isolated leptons [1]. One of the most interesting and widely discussed signatures for SUSY discovery at the LHC is the signature with two opposite charge and the same flavour leptons [2]: $l^+l^- \ + \ E_T^{miss}$. The main reason of such interest is that neutralino decays into leptons and LSP $\tilde{\chi}_2^0 \ \rightarrow \ l^+l^-\tilde{\chi}_1^0$ contribute to this signature and the distribution of the l^+l^- invariant mass $m_{inv}(l^+l^-)$ has the edge structure [3] that allows to determine some combination of the SUSY masses.

The signature $e^\pm\mu^\mp \ + \ E_T^{miss}$, can also be produced when the χ_2^0 decays into τ pair which is only relevant at large $\tan\beta$ [4]. Also as it is shown in Ref. [3] at the level of CMSJET [5] simulation the use of $e^\pm\mu^\mp \ + \ E_T^{miss}$ signature for large $\tan\beta$ allows to obtain nontrivial information on parameters of the decay $\tilde{\chi}_2^0 \rightarrow \tilde{\tau}\tau \rightarrow \tau\tau\tilde{\chi}_1^0 \rightarrow e^\pm\mu^\mp\tilde{\chi}_1^0\nu\nu\bar{\nu}\bar{\nu}$. On the other hand, the $e^\pm\mu^\mp \ + \ E_T^{miss}$ (with an arbitrary number of jets), can be used for the detection of lepton flavour violation in slepton decays [6]-[13] at the LHC.

In the Minimal Supersymmetric Model (MSSM) [14] supersymmetry is broken at some high scale M by generic soft terms, so in general all soft SUSY breaking terms are arbitrary which complicates the analysis and spoils the predictive power of the theory. In the Minimal Supergravity Model (mSUGRA) [14] the universality of the different soft parameters at the Grand Unified Theory (GUT) scale $M_{GUT} \approx 2 \cdot 10^{16}$ GeV is postulated. Namely, all the spin zero particle masses (squarks, sleptons, higgses) are postulated to be equal to the universal value m_0 at the GUT scale. All gaugino particle masses are postulated to be equal to the universal value $m_{1/2}$ at GUT scale. Also the coefficients in front of quadratic and cubic SUSY soft breaking terms are postulated to be equal. The renormalization group equations are used to relate GUT and electroweak scales. The equations for the determination of a nontrivial minimum of the electroweak potential are used to decrease the number of the unknown parameters by 2. So the mSUGRA model depends on five unknown parameters. At present, the more or less standard choice of free parameters in the mSUGRA model includes $m_0, m_{1/2}, \tan\beta, A$ and $sign(\mu)$ [14]. All sparticle masses depend on these parameters.

The goal of this work is to search for the possibility to detect SUSY and lepton flavour violation (LFV) using the $e^\pm\mu^\mp \ + \ E_T^{miss}$ signature at the LHC for the Compact Muon Solenoid (CMS) detector at the level of full detector simulation. For specific calculations the mSUGRA model is used.

The organization of the paper is the following. Section 2 describes some useful technical details of performed simulations. In Section 3 the backgrounds and cuts used to suppress the backgrounds are discussed. Section 4 contains the results of numerical calculations concerning the possibility to detect SUSY using the $e^\pm\mu^\mp \ + \ E_T^{miss}$ signature. In Section 5 the prospects of the detection lepton flavour violation in the neutralino decays is studied. In Section 6 the influence of the systematic uncertainties on the value of the signal significance is discussed. Section 7 contains concluding remarks.

2 Simulation details

The coupling constants and cross sections in the leading order (LO) approximation for SUSY processes and backgrounds were calculated with ISASUGRA 7.69 [16], PYTHIA 6.227 [18] and CompHEP 4.2pl [19]. For the calculation of the next-to-leading order (NLO) corrections to the SUSY cross sections the PROSPINO [17] code was used. For considered signal events and backgrounds the NLO corrections are known and the values of NLO cross sections (or k-factors) were used for normalization of the numerical results.

Official datasets (DST) production was used for the study of CMS SUSY test points (LM1, LM4, LM5, LM9), lepton flavour violation for the point LM1 and of backgrounds ($\mathrm{t\bar{t}}$, ZZ, WW, Wt, $\mathrm{Zb\bar{b}}$, DY2τ). The ISASUGRA 7.69 + PYTHIA 6.225 codes were used in official production. The full detector simulation was made with OSCAR_2_4_5 or OSCAR_3_6_0 [20] codes. Digitization was made with ORCA_7_6_1, ORCA_8_5_0 or ORCA_8_7_1 [20] codes.

For other CMS SUSY test points (LM2, LM3, LM6, LM7, LM8) and WZ background the events were generated with ISASUGRA 7.69 + PYTHIA 6.227 codes and CMKIN_4_3_1 [20] was used as an interface program. The detector simulation and hits production for the test points (LM2, LM3, LM6) and WZ background were made with OSCAR_3_6_5 and for digitization ORCA_8_7_3 was used. To study the two test points LM7 and LM8, background Z+jet and to prepare the CMS discovery plot, the CMS fast simulation program $FAMOS\_1\_4\_0$ [20] was used.

The pile-up for the signal events are not taken into account, but backgrounds in DSTs were produced with pile-up corresponding to $2 \times 10^{33} cm^{-2} s^{-1}$ luminosity.

The reconstructed electrons and muons were passed through packages defining lepton isolation criteria. For each electron and muon the following parameters are defined:

- $TrackIsolation$ is a number of additional tracks with $p_T > 2$ GeV/c inside a cone with $R \equiv \sqrt{\Delta\eta^2 + \Delta\Phi^2} < 0.3$ around the lepton.
- $CaloIsolation$ is a ratio of energy deposited in the calorimeters (electromagnetic (ECAL) + hadronic (HCAL)) inside a cone with $R = 0.13$ around given track to the energy deposited inside a cone with $R = 0.3$.
- $HEratio$ is defined as a ratio of energy deposited in the HCAL inside a cone with $R = 0.13$ to the energy deposited in the ECAL inside the same cone.
- $EPratio$ is a ratio of energy deposited in the ECAL inside a cone with $R = 0.13$ to the momentum of the reconstructed track.

Data with reconstructed electrons, muons, jets and missing energy were stored into ROOT [21] files for the final analysis.

The official datasets used for these analysis were processed with CRAB [22].

3 Signal selection and backgrounds

The SUSY production $pp \to \tilde{q}\tilde{q}^{'}, \tilde{g}\tilde{g}, \tilde{q}\tilde{g}$ with subsequent decays

$$\tilde{q} \to q^{'} \tilde{\chi}^{\pm}_{1,2}, \tag{1}$$

$$\tilde{g} \to q\bar{q}^{'} \tilde{\chi}^{\pm}_{1,2}, \tag{2}$$

$$\tilde{\chi}^{+}_{1,2} \to \tilde{\chi}^{0}_{1} e^{+}(\mu^{-})\nu, \tag{3}$$

$$\tilde{\chi}^{-}_{1,2} \to \tilde{\chi}^{0}_{1} \mu^{-}(e^{-})\nu, \tag{4}$$

leads to the event topology $e^{\pm}\mu^{\mp} + E_T^{miss}$. Note that in the MSSM with lepton flavour conservation neutralino decays into leptons $\tilde{\chi}^0_{2,3,4} \to l^+l^-\tilde{\chi}^0_1$ ($l \equiv e, \mu$) do not contribute into this signature and contribute only to the $l^+l^- + E_T^{miss}$ signature. The main backgrounds which contribute to the $e^{\pm}\mu^{\mp}$ events are: $\mathrm{t\bar{t}}$, WW, WZ, ZZ, Wt, $\mathrm{Zb\bar{b}}$, DY2τ and Z+jet. It is found that $\mathrm{t\bar{t}}$ is the largest background and it gives more than 50% contribution to the total background. The following NLO values for the main background cross sections [23, 24] are used (Table 1).

Table 1: The main background cross sections (in pb).

Process	σ_{LO}	σ_{NLO}
$\mathrm{t\bar{t}}$	505	830
WW	70	117
WZ	27	50
ZZ	11	16
Wt	30	62
$\mathrm{Zb\bar{b}}$	790	1580
Z+jet, ckin(3) = 100	240	274
DY2τ	39600	

In the final analysis the events with the following isolation criteria for electrons were used: $TrackIsolation < 1.0$, $CaloIsolation > 0.85$, $0.85 < EPratio < 2.0$, $HEratio < 0.25$. The same criteria for muons were the following: $TrackIsolation < 1.0$, $CaloIsolation > 0.50$, $EPratio < 0.20$, $HEratio > 0.70$. These numbers were adjusted by studying electron and muon tracks in the process $pp \to WW \to 2l$.

The selection cuts are the following:

- cut on leptons: $p_T^{lept} > p_T^{lept,0}$, $|\eta| < 2.4$, lepton isolation within $\Delta R < 0.3$ cone

- cut on missing transverse energy: $E_T^{miss} > E_T^{miss,0}$.

Where $p_T^{lept,0}$ and $E_T^{miss,0}$ are corresponding thresholds.

3.1 Trigger selection

The events are required to pass the Global Level 1 Trigger (L1) [25] and the High Level Trigger (HLT) [26]. The events have to pass at least one of the following triggers: single electron, double electron, single muon, or double muon. The used cut on leptons is more stringent than the cuts used in the HLT for these triggers.

4 Use of the $e^{\pm}\mu^{\mp} + E_T^{miss}$ signature for the SUSY detection

The possibility to detect SUSY using the CMS test points LM1 - LM9 [15] are chosen for the detailed study of SUSY detection at CMS is investigated in this section. This study is based on the counting the expected number of events for both the SM and the mSUGRA models. The parameters of the CMS test points LM1 - LM9 are given in Table 2.

Table 2: The parameters of the CMS test points.

Point	m_0 (GeV)	$m_{1/2}$(GeV)	$\tan\beta$	$sign(\mu)$	A_0
LM1	60	250	10	+	0
LM2	185	350	35	+	0
LM3	330	240	20	+	0
LM4	210	285	10	+	0
LM5	230	360	10	+	0
LM6	85	400	10	+	0
LM7	3000	230	10	+	0
LM8	500	300	10	+	-300
LM9	1450	175	50	+	0

For the point LM1 (the point LM1 coincides with the post-WMAP point B [27]) the distributions on p_T^{lept}, E_T^{miss} and $m_{inv}(e^+\mu^- + e^-\mu^+)$ for both background and signal events are shown in Figs.1-4.

It was found that the set of cuts with $p_T^{lept} > 20$ GeV/c, $E_T^{miss} > 300$ GeV is close to the optimal set (the highest significance with the best signal/background ratio). The results for the luminosity $\mathcal{L} = 10\ fb^{-1}$ are presented in Table 3.

For other CMS SUSY test points LM2 - LM9 the results with the same set of cuts are presented in Table 4. The significances definitions in this table are the following: $S_{c12} = 2(\sqrt{N_S + N_B} - \sqrt{N_B})$ [28] and $S_{cL} = \sqrt{2((N_S + N_B)\, ln(1 + \frac{N_S}{N_B}) - N_S)}$ [29].

Table 3: The expected number of events for backgrounds and for signal at the point LM1, $\mathcal{L} = 10\ fb^{-1}$, $e^{\pm}\mu^{\mp} + E_T^{miss}$ signature.

Process	2 isolated leptons, $p_T^{lept} > 20$ GeV/c	$E_T^{miss} > 300$ GeV
$t\bar{t}$	39679	79
WW	4356	4
WZ	334	2
ZZ	38	0
Wt	3823	2
Zbb	315	0
Z+jet	1082	6
DY2τ	7564	0
SM background	57191	93
LM1 Signal	1054	329

Table 4: The number of signal events and significances for cut set with $p_T^{lept} > 20$ GeV/c and $E_T^{miss} > 300$ GeV for $\mathcal{L} = 10\ fb^{-1}$, signature $e^{\pm}\mu^{\mp}\ +\ E_T^{miss}$. The number of the SM background events N_B = 93 (see Table 3).

Point	N events	S_{c12}	S_{cL}
LM1	329	21.8	24.9
LM2	94	8.1	8.6
LM3	402	25.2	29.2
LM4	301	20.4	23.1
LM5	91	7.8	8.3
LM6	222	16.2	18.0
LM7	14	1.4	1.4
LM8	234	16.9	18.8
LM9	137	11.0	11.9

It was found from the Tables 3-4 that for the point LM1 the significances are $S_{c12}/S_{cL} = 21.8/24.9$ for the $e^{\pm}\mu^{\mp}\ +\ E_T^{miss}$ signature.

The supersymmetry discovery potential for the mSUGRA model with $\tan\beta = 10$, $sign(\mu) = +$ in the $(m_0,\ m_{1/2})$ plane (generalization of the point LM1) using the CMS fast simulation program $FAMOS\_1\_4\_0$ [20] was also studied. The CMS discovery potential contours for $\mathcal{L} = 1, 10$ and $30\ fb^{-1}$ for the signature $e^{\pm}\mu^{\mp}\ +\ E_T^{miss}$ are shown in Fig.8.

4.1 The comparison of the FAMOS and the full simulation for the point LM1

The results obtained with the FAMOS code were compared with the full simulation results. The test point LM1 was used as the comparison object. The distributions on p_T^{lept} and E_T^{miss} of the LM1 signal for both FAMOS and ORCA are shown in Figs.5,6.

From the Figs. 5,6 it is possible to conclude that the full and the fast simulation distributions on p_T^{lept} and E_T^{miss} for the point LM1 are in reasonable agreement.

5 Search for lepton flavour violation in the neutralino decays

In the MSSM the off-diagonal components of the slepton mass terms violate lepton flavour conservation. As it has been shown in Refs.[6],[7] it is possible to look for lepton flavour violation at supercolliders through the production and decays of the sleptons. For the LFV at the LHC, one of the most promising processes is the LFV decay of the second neutralino [9],[10] $\tilde{\chi}_2^0 \to \tilde{l}l \to \tilde{\chi}_1^0\, ll^{'}$, where the non zero off-diagonal component of the slepton mass matrix leads to different lepton flavours in the final state. This mode is more sensitive to LFV compared to the direct Drell-Yan production of sleptons since the second neutralino $\tilde{\chi}_2^0$ can be copiously produced through the cascade decays of squarks and gluinos [8]. By using the above mode, LFV in $\tilde{e} - \tilde{\mu}$ mixing has been investigated in Refs.[9],[10] at a parton model level for a toy detector. In this section the perspectives of LFV detection in CMS on the base of full simulation of both signal and background is studied. To be specific, the test point LM1 is studied. The signal of LFV $\tilde{\chi}_2^0$ decay is the two opposite-sign leptons ($e^+\mu^-$ or $e^-\mu^+$) in the final state with the characteristic edge structure. In the limit of lepton flavour conservation, the process $\tilde{\chi}_2^0 \to \tilde{l}l \to ll\tilde{\chi}_1^0$ has the edge structure for the distribution of lepton-pair invariant mass m_{ll} and the edge mass $m_{inv}^{max}(l^+l^-)$ is expressed by slepton mass $m_{\tilde{l}}$ and neutralino masses $m_{\tilde{\chi}_{1,2}^0}$ as follows [3]:

$$(m_{inv}^{max}(l^+l^-))^2 = m_{\tilde{\chi}_2^0}^2(1 - \frac{m_{\tilde{l}}^2}{m_{\tilde{\chi}_2^0}^2})(1 - \frac{m_{\tilde{\chi}_1^0}^2}{m_{\tilde{l}}^2}) \tag{5}$$

The SUSY background for LFV comes from uncorrelated leptons from different squark or gluino decay chains. The SM background comes mainly from

$$t\bar{t} \to bWbW \to blbl^{'}\nu\nu^{'}. \tag{6}$$

It should be stressed that the signature with $e^{\pm}\mu^{\mp}$ in the absence of LFV do not have the edge structure for the distribution on invariant mass $m_{inv}(e^{\pm}\mu^{\mp})$. As the result of LFV the edge structure for $e^{\pm}\mu^{\mp}$ events arises too.

Therefore the signature of LFV is the existence of an edge structure for the $e^{\pm}\mu^{\mp}$ distribution. The rate for a flavour violating decay is determined by nonzero κ, where

$$\kappa = \frac{Br(\tilde{\chi}_2^0 \to e^{\pm}\mu^{\mp}\ \tilde{\chi}_1^0)}{Br(\tilde{\chi}_2^0 \to e^+e^-\tilde{\chi}_1^0, \mu^+\mu^-\tilde{\chi}_1^0)} \tag{7}$$

In this paper the observability of LFV for the point LM1 was studied. For this purpose a special sample of events with 100% LFV was prepared. For $\kappa = 0.10$, $\kappa = 0.25$ the distributions of the number of $e^{\pm}\mu^{\mp}$ events on invariant mass $m_{inv}(e^{\pm}\mu^{\mp})$ (Fig.7) clearly exhibit the edge structure, i.e. the existence of the lepton flavour violation in neutralino decays.

It appears that for the point LM1 the use of an additional cut

$$m_{inv}(e^{\pm}\mu^{\mp}) < 85 \text{ GeV} \tag{8}$$

reduces both SM and SUSY backgrounds and increases the discovery potential in the LFV search. In this case the cuts $p_T^{lept} > 40$ GeV/c and $E_T^{miss} > 200$ GeV give the best result. For instance, it was found that $N_{SMbg} = 19$ and $N_{SUSYbg} = N_{LM1signal} = 71$ for the $e^{\pm}\mu^{\mp}$ signature (see Table 3 for comparison where $N_{SMbg} = 93$ and $N_{LM1signal} = 329$).

It was found that for the point LM1 in the assumption of exact knowledge of backgrounds (both SM and SUSY backgrounds) for the integral luminosity of $\mathcal{L} = 10 fb^{-1}$ it would be possible to detect LFV at a 5σ level in $\tilde{\chi}_2^0$ decays for $\kappa \geq 0.04$.

6 Influence of the systematic uncertainties on the signal significance

In this Section the influence of systematic uncertainties on the value of signal significance in the case of SUSY detection is estimated. The systematic uncertainties in the signal significance calculation include the experimental selection uncertainty of the background events, luminosity uncertainty, and the theoretically calculated uncertainties of the $t\bar{t}$, WW and other backgrounds. Theoretically calculated uncertainty in background cross sections consists of the uncertainty related with inexact knowledge of parton distribution functions (PDF) and higher order corrections to the NLO cross sections [30]. There are several experimental uncertainties related with lepton identification, missing energy and luminosity. In accordance with Ref.[31] the systematic error related with the lepton identification is 3%, the systematic error related with the missing energy is 2% [32].

It was found that the experimental uncertainties in the number of background events N_B related with the missing energy and the lepton identification lead to 10% and 0.5% uncertainties in the number of the N_B respectively.

The systematic uncertainty in the luminosity is 5% [33]. The total 5% uncertainty in luminosity leads to 5% uncertainty in the number of background events.

In the studying signature the $t\bar{t}$ background dominates. The PDF uncertainty of $t\bar{t}$ cross section is equal to 5% and the uncertainty due to unknown higher order corrections to the NLO background cross section is equal to 10%. In the assumption that the systematic uncertainties are added quadratically it was found that the overall uncertainty in the number of background events is about 16%.

Following the prescriptions of the CMS PRS group the influence of the systematic uncertainties on signal significance using the program for calculations of significance S_cP from Ref.[34] was calculated. The results are shown in Table 5.

The discovery potential decreases with the increase of the background uncertainty but nevertheless the results are rather robust. In particular, it was found that for 0, 10, 20% background uncertainties it is possible to detect at the point LM1 lepton flavour violation in neutralino decays for $\kappa \geq 0.04, 0.043, 0.051$ respectively.

7 Conclusion

In this paper the possibility to detect SUSY and lepton flavour violation at the LHC (CMS) using the signature $e^{\pm}\mu^{\mp} + E_T^{miss}$ was studied. This signature allows to discover both SUSY and LFV in the neutralino decays. It was found that for the CMS test points LM1 - LM9 for integral luminosity $\mathcal{L} = 10\ fb^{-1}$ it is possible to discover SUSY for all LM points except for LM7. For $\tan\beta = 10,\ A = 0,\ sign(\mu) = +$ the discovery contours for $\mathcal{L} = 1,\ 10$ and $30\ fb^{-1}$ in the $(m_0,\ m_{1/2})$ plane were determined. The possibility to look for lepton

Table 5: The dependence of signal significance S_{c12} on background uncertainty for the used set of cuts and $\mathcal{L} = 10\ fb^{-1}$ for signature $e^{\pm}\mu^{\mp}\ +\ E_T^{miss}$.

Point	0%	10%	20%
LM1	21.8	15.7	10.0
LM2	8.1	5.8	3.7
LM3	25.2	18.1	11.6
LM4	20.4	14.7	9.4
LM5	7.8	5.6	3.6
LM6	16.2	11.7	7.5
LM7	1.4	1.0	0.6
LM8	16.9	12.1	7.8
LM9	11.0	7.9	5.1

flavour violation in neutralino decays was also studied. It was found that for the point LM1 it is possible to detect lepton flavour violation provided the lepton flavour violating branching $Br(\tilde{\chi}_2^0 \to \mu^{\pm}e^{\mp}\tilde{\chi}_1^0) \geq 0.04 Br(\tilde{\chi}_2^0 \to e^+e^-\tilde{\chi}_1^0, \mu^+\mu^-\tilde{\chi}_1^0)$ for $\mathcal{L} = 10\ fb^{-1}$. The results for the significances are rather robust under the inclusion of reasonable systematic uncertainties.

It should be stressed that the signature $e^{\pm}\mu^{\mp}\ +\ E_T^{miss}$ is less "powerful" from the point of view of SUSY discovery that say the signature $(n\ \geq\ 3\ jets) + E_T^{miss}$ [3], however it is important to detect "new physics" using simultaneously different signatures that increases the credibility of the results.

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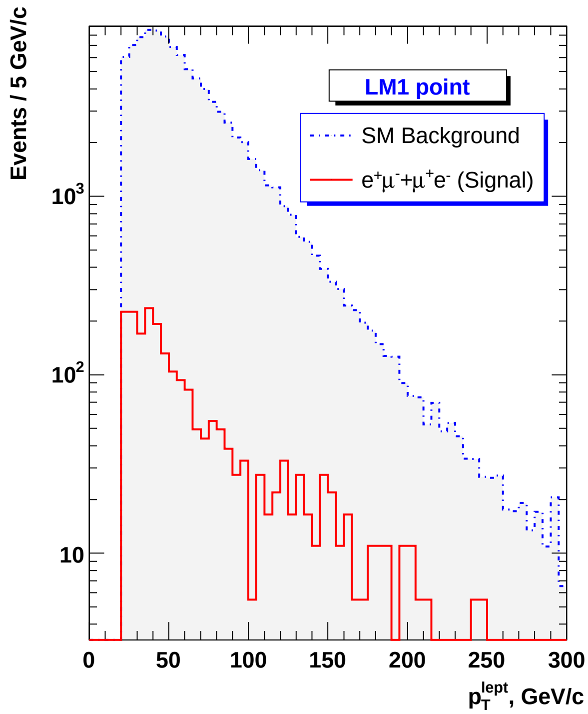

Figure 1: The p_T^{lept} distribution after selection of two isolated leptons with $p_T^{lept} > 20$ GeV/c. The both leptons are plotted.

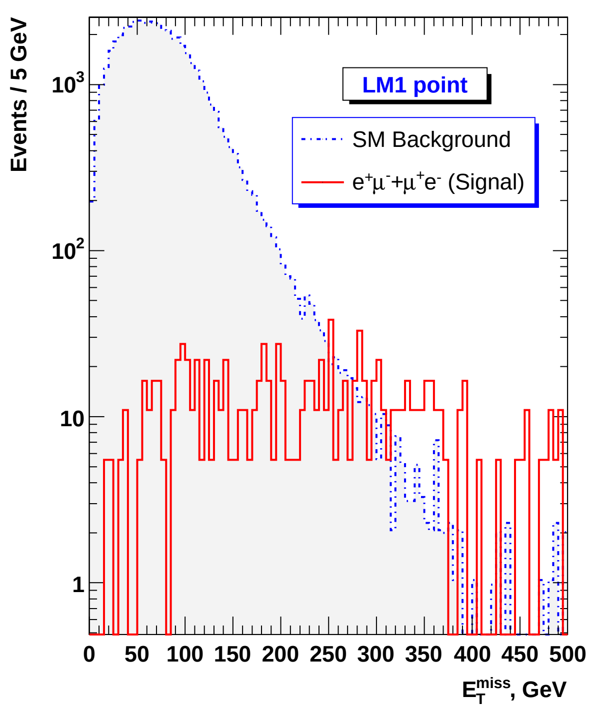

Figure 2: The E_T^{miss} distribution after selection of two isolated leptons with $p_T^{lept} > 20$ GeV/c.

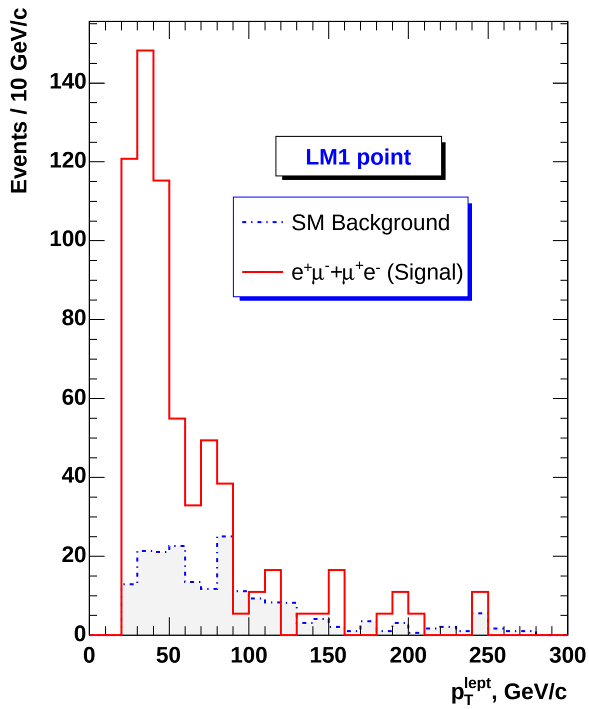

Figure 3: The p_T^{lept} distribution after selection of two isolated leptons with $p_T^{lept} > 20$ GeV/c and $E_T^{miss} >$ 300 GeV.

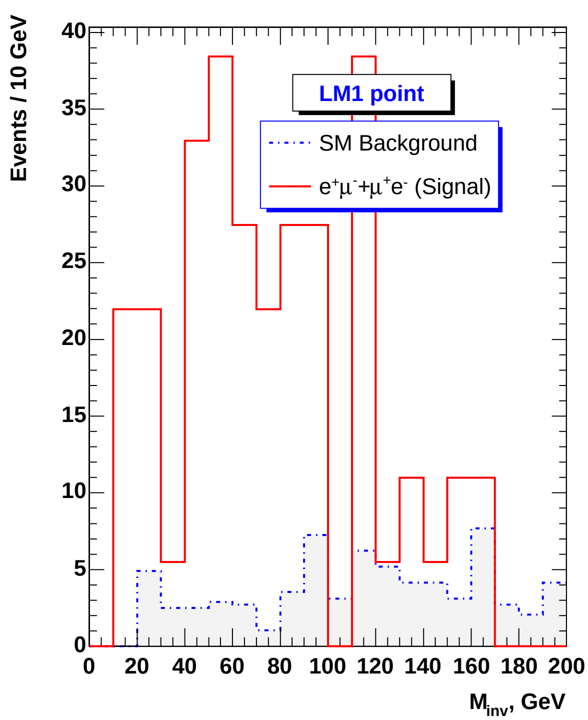

Figure 4: The invariant two lepton mass distribution after selection of two isolated leptons with $p_T^{lept} > 20$ GeV/c and $E_T^{miss} > 300$ GeV.

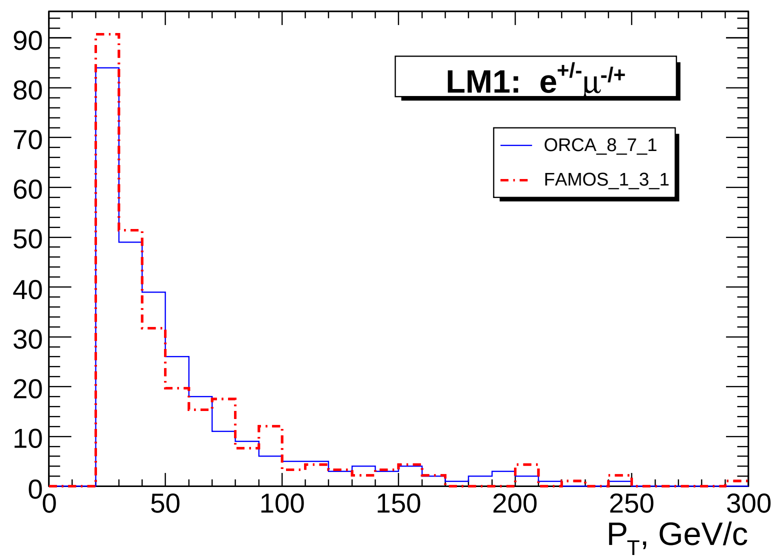

Figure 5: The p_T^{lept} distribution after selection of two isolated leptons with $p_T^{lept} > 20$ GeV/c for ORCA and FAMOS. The plots are normalized to the numbers of dileptons.

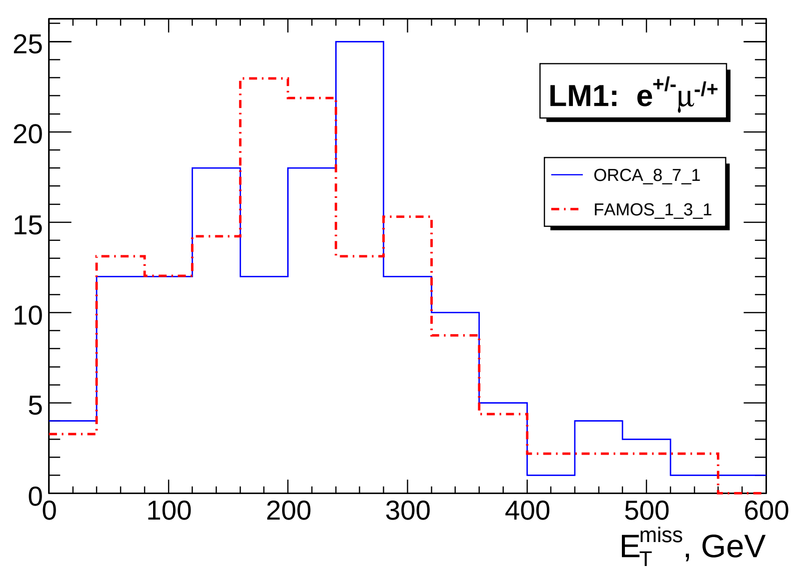

Figure 6: The E_T^{miss} distribution after selection of two isolated leptons with $p_T^{lept} > 20$ GeV/c for ORCA and FAMOS. The plots are normalized to the numbers of dileptons.

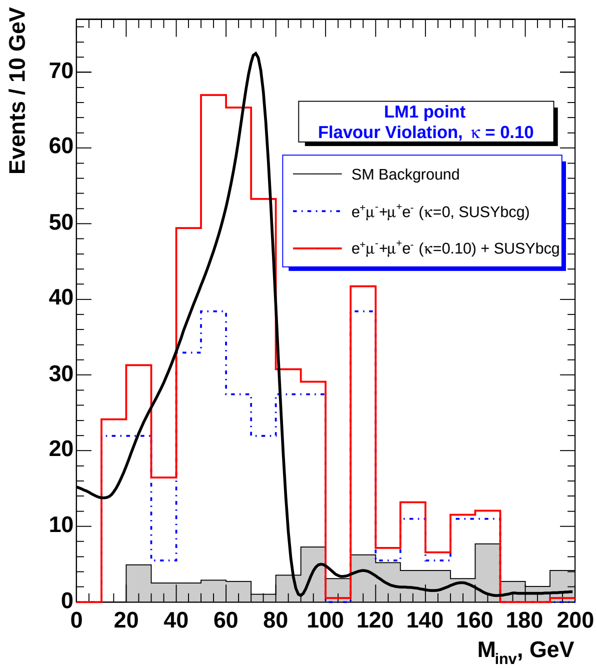

Figure 7: The distribution of two lepton invariant mass after selection of two isolated different-flavour leptons with $p_T^{lept} > 20$ GeV/c and $E_T^{miss} > 300$ GeV for flavour violation parameter $\kappa = 0.10$ and $\kappa = 0.25$. Superimposed curves are fits to the invariant mass distribution for 100% LFV.

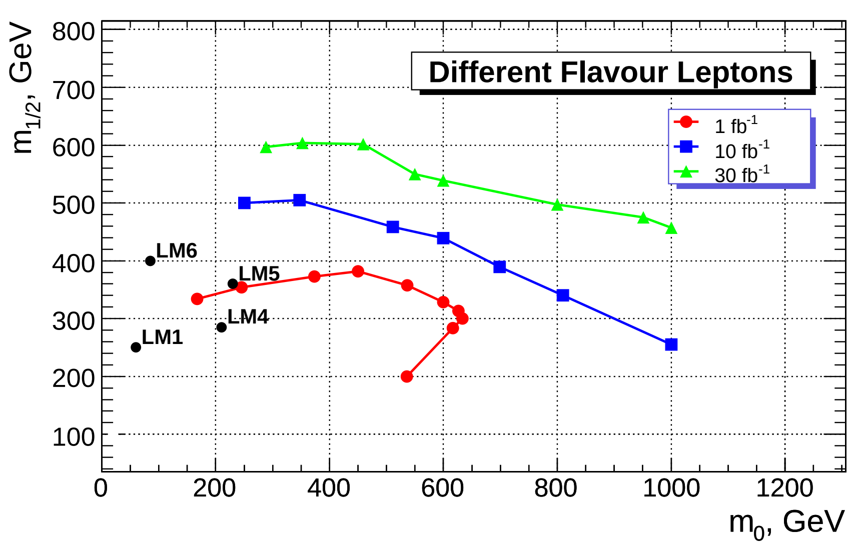

Figure 8: $e^+\mu^- + e^-\mu^+$ discovery plot for $\tan\beta = 10$, $sign(\mu) = +$, $A = 0$. Selected two isolated leptons with $p_T^{lept} > 20$ GeV/c and $E_T^{miss} > 300$ GeV. Calculations are made for S_{c12}.

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