Search for RpV SUSY in the eel (l=e or μ) channel (λ_{121} coupling)

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abstract

A search has been performed for the eel (l = e or μ) signature from the R-parity Conserved (RpC) production of Supersymmetric particles followed by a R-parity Violating (RpV) decay through a λ_{121} coupling . The analysis uses data collected with the DØ detector at Fermilab $p\bar{p}$ collider at a center of mass of 1.96 TeV during the period September 2002-January 2004 and corresponding to 176 ± 9 pb^{-1}. Events triggered by a single-EM, a di-EM trigger or a single muon trigger were selected. 3 events were found for 4.5 ± 0.9 events expected from the Standard Model and from the instrumental background. Preliminary study of the region which can be excluded in the mSUGRA parameter space is presented for m_0=250 Gev/c^2, tan$\beta = 5$ and both signs of μ.

1 Introduction

A multi-lepton topology is expected in the RpV SUSY processes via the λ_{121} Yukawa coupling. In this analysis it is assumed that the production is Rp conserved (production of a pair of SUSY particles). The Supersymmetric partcles decay can decay via RpC or RpV. The pair of SUSY particles produced cascade decay almost 100 % of the time to a pair of $\tilde{\chi}_1^0$ which then decay through RpV. Figure 1 illustrates the four decay channels of the $m_{\tilde{\chi}_1^0}$ into the four equally probable channels : e$^-$ e$^+$ $\bar{\nu_\mu}$, e$^+$ e$^-$ ν_μ, $\bar{\nu_e}\mu^- e^+$, $\nu_e\mu^+ e^-$.

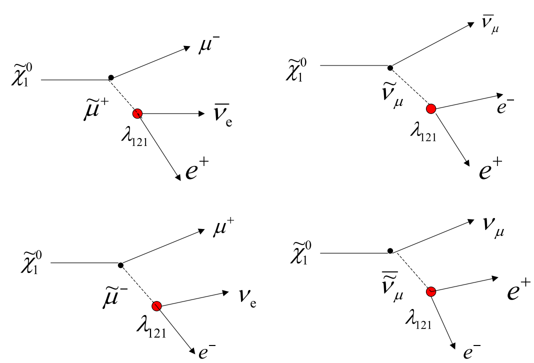

Figure 1: Diagrams of $\tilde{\chi}_1^0$ RpV decay to three leptons (λ_{121} coupling).

At least 4 charged leptons should be present in the final state. As some leptons can escape detection, the present analysis is relative to the eel final state(l = e or μ).

The analysis presented in this note is done on ThumbNails [1].

2 Real Data Sample

The data set used for this study is the CSG di-EM streaming sample corresponding to the data taking period extending from September 2002 to January 2004 [2]. Events are selected if they contain at least 2 EM candidates (ID = 10 OR |ID| = 11 with $p_T > 8$ GeV). Events with bad luminosity block (JETMET, known badM UO or CAL) are not considered. Bad MUO or CAL runs are rejected. Duplicated events are counted only once.

3 MC samples : SM physics processes and SUSY signal

Standard Model processes have been generated with PYTHIA 6.202 [13] (Table 1) .

SM process (masses in GeV/c^2)	$\sigma\times$ Br pb	Nb events	$\mathcal{L}_{equivalent}$ pb^{-1}
$\gamma^*/Z \to ee$ (2 – 15)	27884 ± 300	19750	0.7
$\gamma^*/Z \to ee$ (15 – 60)	475 ± 50	100000	211
$\gamma^*/Z \to ee$ (60 – 130)	294 ± 32	148250	506
$\gamma^*/Z \to ee$ (130 – 250)	1.41 ± 0.01	11500	8156
$\gamma^*/Z \to ee$ (250 – 500)	0.115 ± 0.001	10000	86956
$\gamma^*/Z \to \tau\tau$ (15 – 60)	475 ± 50	22000	46
$\gamma^*/Z \to \tau\tau$ (60 – 130)	294 ± 32	128250	436
$\gamma^*/Z \to \tau\tau$ (130 – 250)	1.41 ± 0.01	10000	7092
$\gamma^*/Z \to \tau\tau$ (250 – 500)	0.115 ± 0.001	10000	86956
WW $W \to e\nu$ and $\mu\nu_\mu$ $WW \to ll \to \tau+$ X	0.285 ± 0.003	40000	140351
WZ $W \to e\nu$ and $\mu\nu_\mu$ $Z \to ee$ and $\mu\mu$	0.156 ± 0.003	2500	16025
$ZZ \to lljj$	0.075 ± 0.035	24000	32000
$W\gamma \to e\nu\gamma$	17.3 ± 0.2	9500	549
$Z\gamma \to ee\gamma$	4.2 ± 0.7	5000	1190
$W \to e\nu$	1899 ± 28	434735	229
$t\bar{t}$ incl	5.93 ± 0.13	2750	464
$\Upsilon \to ee$	$XXX \pm XXX$	32000	XXX

Table 1: MC samples analyzed in the eel (l=e or μ) search. The Drell-Yan cross sections for the mass range 15-60 GeV/c^2 has been multiplied by a factor K= 1.3 [3].

Signal events have been generated with SUSYGEN [5] which uses SUSPECT [6] for RGE evolution. CTEQ5L parton distribution functions were selected and events were combined with an average of 0.8 minimum-bias. Events have been generated with the lepton violating coupling $\lambda_{121} = 0.01$ (present experimental upper limit is 0.05 [7]). The value of the coupling influences only the lifetime of the $\tilde{\chi}_1^0$. With chosen value for λ_{121}, the $\tilde{\chi}_1^0$ decays within few mm. For each SUSY point around 9000 events have been generated. Tables 2 and 3 show the masses of $\tilde{\chi}_1^0$, $\tilde{\chi}_2^0$ and $\tilde{\chi}_1^+$ and neutralino and/or chargino pair production cross section for some points in the parameter space (m$_0$=250 GeV/c^2, tanβ=5 and both signs of μ). The two dominant processes are neutralino-chargino and chargino-chargino pair production. SUSYGEN gives LO cross sections. PROSPINO cross sections (NLO) will be used to determine excluded limits.

All signal events have been processed through the full detector simulation and reconstructed with d0reco (p14.05.01 and p14.03.02).

Some physical properties of the signal are illustrated by figure 2 (p_T of the first four leading generated electrons and muons for m_0 = 250 GeV/c^2, $m_{1/2}$ = 180 GeV/c^2, tanβ=5 and $\mu < 0$).

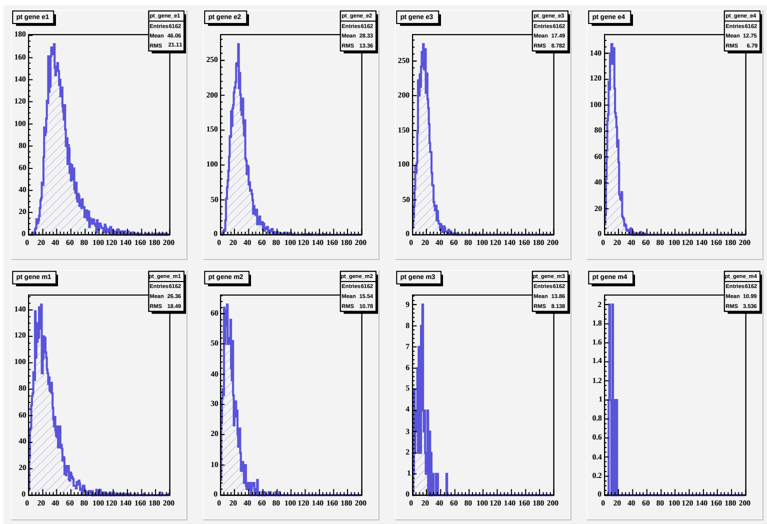

Figure 2: PRELIMINARY : p_T distributions (GeV/c) of the first four leading generated electrons (1st line) and muons (2nd line) for the SUSY point m_0 = 250 GeV/c^2, $m_{1/2}$ = 180 GeV/c^2, tanβ=5 and $\mu < 0$.

$m_{1/2}$ GeV/c^2	$m_{\tilde{\chi}_1^0}$ GeV/c^2	$m_{\tilde{\chi}_2^0}$ GeV/c^2	$m_{\tilde{\chi}_1^+}$ pb	σ_{CC} pb	σ_{NC} pb	σ_{tot} pb
210	86.4	165.9	166.5	0.065	0.093	0.158
195	80.4	153.5	154.1	0.095	0.137	0.232
190	78.3	149.3	149.9	0.108	0.157	0.265
185	76.2	145.2	145.9	0.123	0.180	0.303
180	74.2	141.1	141.8	0.140	0.207	0.347
175	72.1	136.8	137.6	0.160	0.237	0.397
170	70.1	132.8	133.6	0.182	0.273	0.455
165	68.1	128.6	129.5	0.210	0.319	0.529
160	66.9	124.5	125.4	0.242	0.367	0.609
155	64.0	120.4	121.4	0.279	0.427	0.706
150	62.0	116.3	117.3	0.321	0.498	0.819

Table 2: Masses and cross sections for simulated events generated with SUSYGEN (mSUGRA m_0=250 GeV/c^2, tanβ=5 and $\mu < 0$). N stands for any of the four neutralinos and C for any of the two charginos.

$m_{1/2}$ GeV/c^2	$m_{\tilde{\chi}_1^0}$ GeV/c^2	$m_{\tilde{\chi}_2^0}$ GeV/c^2	$m_{\tilde{\chi}_1^+}$ pb	σ_{CC} pb	σ_{NC} pb	σ_{tot} pb
240	93.0	172.8	171.3	0.057	0.083	0.140
225	86.4	159.9	158.2	0.084	0.125	0.209
220	84.3	155.7	153.9	0.096	0.144	0.240
215	82.1	151.5	149.6	0.110	0.166	0.276
210	79.8	147.1	145.2	0.126	0.192	0.318
205	77.6	142.9	140.8	0.145	0.223	0.368
200	75.4	138.7	136.5	0.167	0.260	0.427
195	73.1	134.3	132.0	0.194	0.303	0.497
190	70.9	130.2	127.8	0.225	0.355	0.580
185	68.7	126.0	123.4	0.262	0.417	0.679
180	66.3	121.6	118.9	0.307	0.493	0.800
175	64.1	117.5	114.6	0.358	0.582	0.940
170	61.8	113.3	110.2	0.422	0.688	1.110
165	59.5	109.1	105.8	0.503	0.839	1.352

Table 3: Masses and cross sections for simulated events generated with SUSYGEN (mSUGRA m_0=250 GeV/c^2, tanβ=5 and $\mu > 0$). N stands for any of the four neutralinos and C for any of the two charginos.

4 Offline Objects Selection Criteria

The EM-candidates, jets, MET are selected and corrected according to the certified criteria of the d0correct v00-00-06.

4.1 EM-candidate

The EM-candidate should satisfy the following criteria:

- ID = 10 (no associated track) OR |ID| = 11 (associated track) $p_T > 10$ GeV/c:
  - EM Fraction > 0.9, where EM Fraction is the energy fraction of the EM-candidate in the electromagnetic calorimeter with respect to the total EM-candidate energy.

- $\text{iso} = \frac{E_{\text{tot}}(\mathcal{R}<0.4) - E_{\text{EM}}(\mathcal{R}<0.2)}{E_{\text{EM}}(\mathcal{R}<0.2)} < 0.2$, where iso is the isolation of the EM-candidate, $E_{\text{EM}}(\mathcal{R} < 0.2)$ is the electromagnetic energy within a cone of radius $\mathcal{R} = \sqrt{\Delta\eta^2 + \Delta\varphi^2} = 0.2$ centered around the EM-candidate, $E_{\text{tot}}(\mathcal{R} < 0.4)$ is the total energy contained within a concentric cone of radius $\mathcal{R} = 0.4$;
- track_match_spatial_chi2prob > 0.01
- HMx8 < 20

- SEM and EM candidate (ID = 10 OR |ID| = 11 with $p_T < 10$ GeV/c and HMx8 < 20) :
  - $p_T > 3$ GeV/c
  - $0.6 < E/p < 1.05$
  - EM fraction > 0.85

4.2 Correction to the EM candidates

In this analysis to account for the noise not described in MC, the EM energies have been smeared by a gaussian of $\sigma = 0.047 \times E$ [8].

Furthermore, the EM ID correction factors [8] for higher efficiencies in MC than in data for :

- offline EMID reconstruction (CC = 0.87 ± 0.03 and EC = 0.94 ± 0.06);
- track match (CC = 0.93 ± 0.04 and EC = 0.78 ± 0.07);

have been applied to the MC events (SM and SUSY processes).

4.3 Muons

Muons considered in this analysis satisfy the criteria : medium quality [9], matched with a central track, $5 < p_T < 500$ GeV/c, $|\eta| < 2$ and $\Delta R > 0.4$ from any jet. The data certified ϵ^{μ}_{id} for $p_T > 15$ GeV/c has been used and is reported in Table 4. Note that as ϵ^{μ}_{id} for MC is not quoted in [9] we have assumed it is equal to data. Study done by M.Hohlfeld show that the two figures are equal at 2% level [10]. The track matching efficiency has been taken from M. Hohlfeld note.

	Data	MC	Data/MC
ϵ^{μ}_{id}	0.80	0.80	1
ϵ^{μ}_{TM}	0.92	0.98	0.935 ± 0.03

Table 4: PRELIMINARY: Mu-ID efficiencies in Data and MC and their ratio used in the analysis.

4.4 Jets

The Run II cone (of radius $\mathcal{R} = \sqrt{\Delta\eta^2 + \Delta\varphi^2} = 0.5$) algorithm has been used, with

- $0.05 <$ EM Fraction < 0.95, where EM Fraction is the energy fraction of the jet in the electromagnetic calorimeter with respect to the total jet energy;
- CHF < 0.4, where CHF is the energy fraction of the jet in the coarse hadronic calorimeter with respect to the total jet energy;
- HotF < 10, where HotF is the ratio highest and next-highest cell ET of the jet;
- n90 > 1, where n90 is the number of cells with 90% of the jet energy;
- f90 $< 0.8 - 0.5 *$ CHF or CHF < 0.1 where $f90 = n90/nitm$, CHF=coarse hadronic fraction and $nitm$ is the total number of towers in a jet;
- $E_T > 10$ GeV.

4.5 MET

The missing transverse energy defined by METBCorrCALOMU [11]is used. In the present form of the analysis no cut is made on MET.

5 Trigger efficiency

This analysis is restricted to events satisfying any single-EM or di-EM (except E7*) or single MU trigger. Trigger efficiencies have been studied and parametrized in order to be applied on MC events (SM and signal). Their statistical error has been computed with the EFFIC program [12].

5.1 Single-EM trigger efficiency

The trigger efficiency versus P_T for single electron has been determined using the 1 MU loose CSG sample [2] (all p14.03 : 80 pb^{-1}). Events have been analyzed if they contain one matched EM candidate $P_T > 15$ GeV/c. The trigger efficiency is measured as the fraction of the events which have also fired a single-EM trigger. Figure 3 shows the resulting efficiency as a function of the P_T of the leading EM candidate.

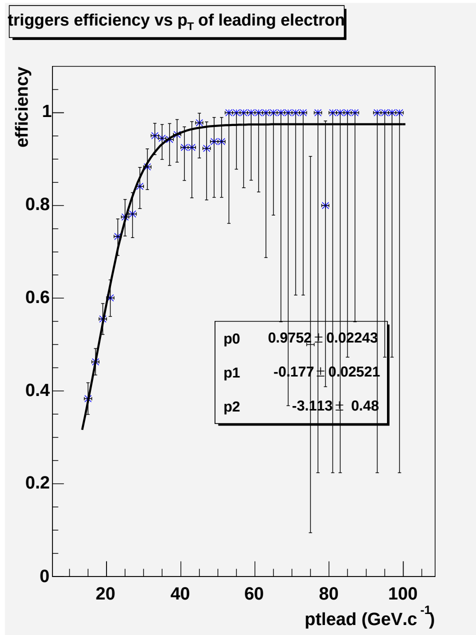

Figure 3: PRELIMINARY: Single-EM trigger efficiency as a function of the p_T of the leading matched electron candidate.

The measured efficiency was fitted as

$$\epsilon(p_T^{EM-candidate}) = \frac{a}{1 + e^{(b \cdot E_T^{EM-candidate} - c)}}$$

The resulting fit parameters are reported in Table 5.

a	b	c
0.9752 ± 0.0224	-0.177 ± 0.025	-3.113 ± 0.480

Table 5: PRELIMINARY: Values of the 3 parameters of the turn-on curve for the single-EM triggers.

5.2 Di-EM trigger efficiency

The di-EM trigger efficiency has been studied as a function of the p_T of the leading electron candidate. The input data sample is the CSG di-EM sample (allp14.03 : 80 pb^{-1}) [2]. The trigger efficiency is studied on events with at least 2 matched EM candidates ($p_T > 8$ GeV/c and outside ICD region) each satisfying the conditions of section 4.1 concerning EM fraction, iso, track_match_spatial_chi2prob and HMx8. It is defined as the ratio of the number of events triggered by any muon trigger and any di-EM trigger over the number of events triggered by any muon trigger. Figure 4 shows the resulting efficiency versus the p_T of the leading.

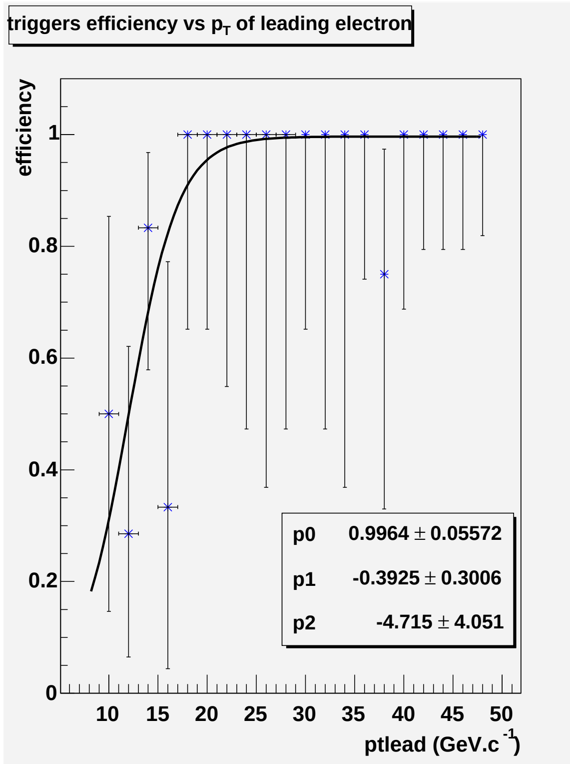

Figure 4: PRELIMINARY: Di-EM trigger efficiency as a function of the p_T of the leading electron candidate.

The measured efficiency was fitted as

$$\epsilon(p_T^{leadingEM-candidate}) = \frac{a}{1 + e^{(b \cdot E_T^{leadingEM-candidate} - c)}}$$

The resulting fit parameters are reported in Table 6.

a	b	c
0.9964 ± 0.0577	-0.3925 ± 0.3006	-4.715 ± 4.051

Table 6: PRELIMINARY: Values of the 3 parameters of the turn-on curve for the DI-EM triggers.

5.3 Single-muon trigger efficiency

The single-muon trigger efficiency is studied on the CSG di-EM sample [2] (all p14.03 : 80 pb^{-1}). It is defined as the ratio of number of events with a muon matched to a central track and triggered by a muon trigger over the number of events with a muon matched to a central track (p_T leading > 5 GeV/c. Figure 5 shows the resulting efficiency as a function of the P_T of the leading muon candidate.

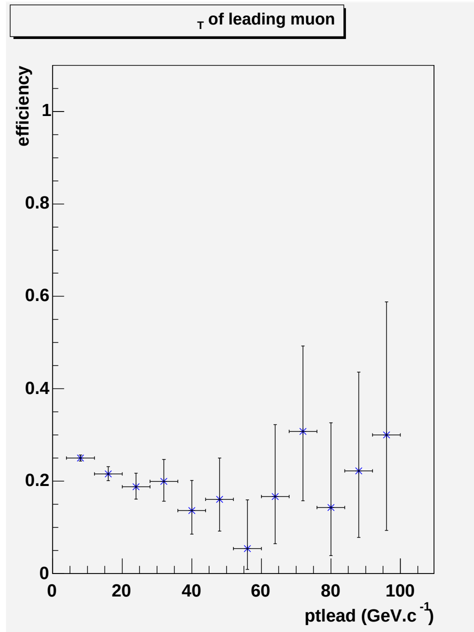

Figure 5: PRELIMINARY: Single-muon trigger efficiency as a function of the p_T of the leading matched electron candidate.

The efficiency of the single mu trigger in this di-EM sample is estimated at $25 \pm 10\%$

5.4 Application of trigger efficiencies to MC

The trigger efficiency has been applied to all MC events (SM processes and SUSY) according to the following procedure :

- for each EM candidate of the event the single-EM turn-on is applied. More precisely a random number between 0 and 1 is chosen and if it is below the turn-on value for this p_T, the event is considered as “triggered”;
- if after this loop on EM candidates none has ”triggered” and if the event contains at least 2 EM candidates the di-EM turn-on is applied as a function of the leading p_T (using the same technic of the random number compared to turn-on value).
- if after this loop on EM candidates none has ”triggered” and if the event contains muons candidates, the single-muon turn-on is applied to each candidate.

6 QCD background

The contribution of QCD multi-jet processes fluctuating to fake electrons is determined from data by inverting the cut on the HMatrix for selection of the electron candidate.

Starting from the selection of events with two EM candidates with one and only one matched to a track, the QCD sample is obtained by selecting the events in which both EM candidates have their HMx8> 30 (the resulting number of events is called QCD_{sample} in the following). This sample is scaled to the number of events satisfying the same criteria except the HMx8 which is required to be < 20. Z and Drell-Yan expected contributions are subtracted from the data using MC events scaled at the same luminosity (the corresponding number of events is called $(Data\text{-}Z\text{-}DY)_{sample}$ in the following). Scaling factors defined as the ratio of $(Data\text{-}Z\text{-}DY)_{sample}$ over QCD_{sample} have been determined for thre categories of EM pairs : CCCC (0.420 $\pm$0.084), ECCC (0.865 $\pm$0.172), ECEC (2.46 $\pm$ 0.49). For each category the contribution of background coming from QCD is defined as : QCD_{bkg}=scaling factor$\times$ QCD_{sample}. In this analysis, the relative error on QCD_{bkg} has been set to 20%.

Figures 6, 7 and 8 present the distributions of di-EM invariant mass with the QCD (brown) and Standard Model backgrounds (at least one electron is matched).

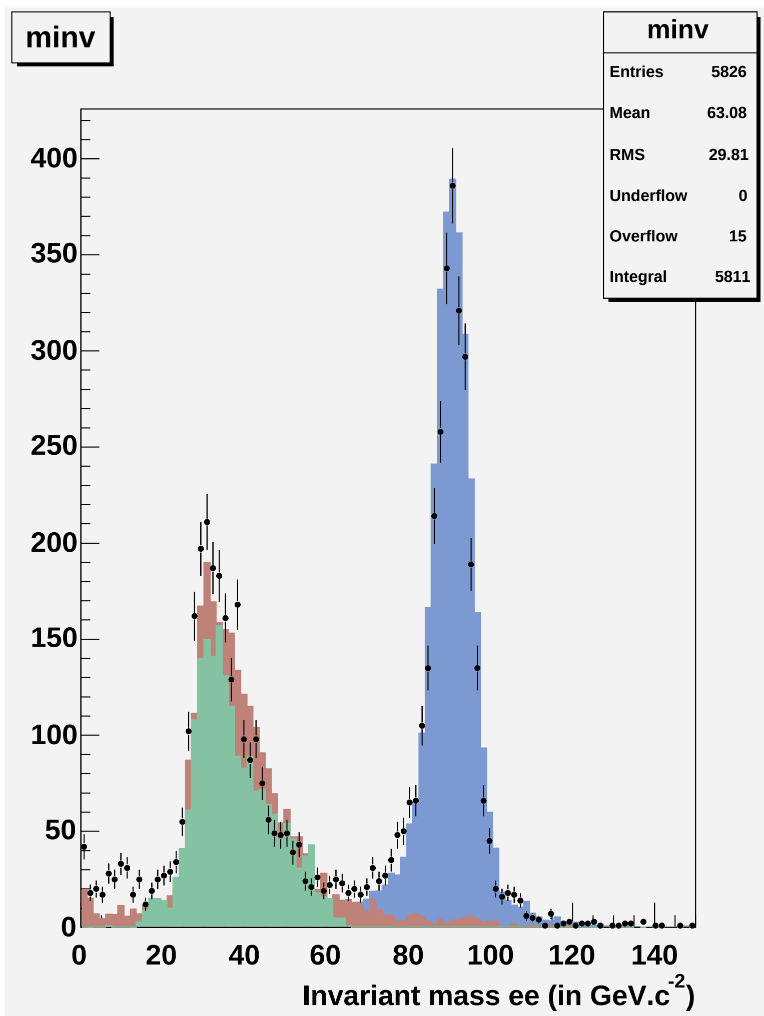

Figure 6: PRELIMINARY : QCD background study in CCCC. Distributions of “di-EM” invariant mass (at least one electron is matched). Data : points, histogram : Drell-Yan (green), Z (blue) and $\mathrm{QCD}_{bkg}(brown)$.

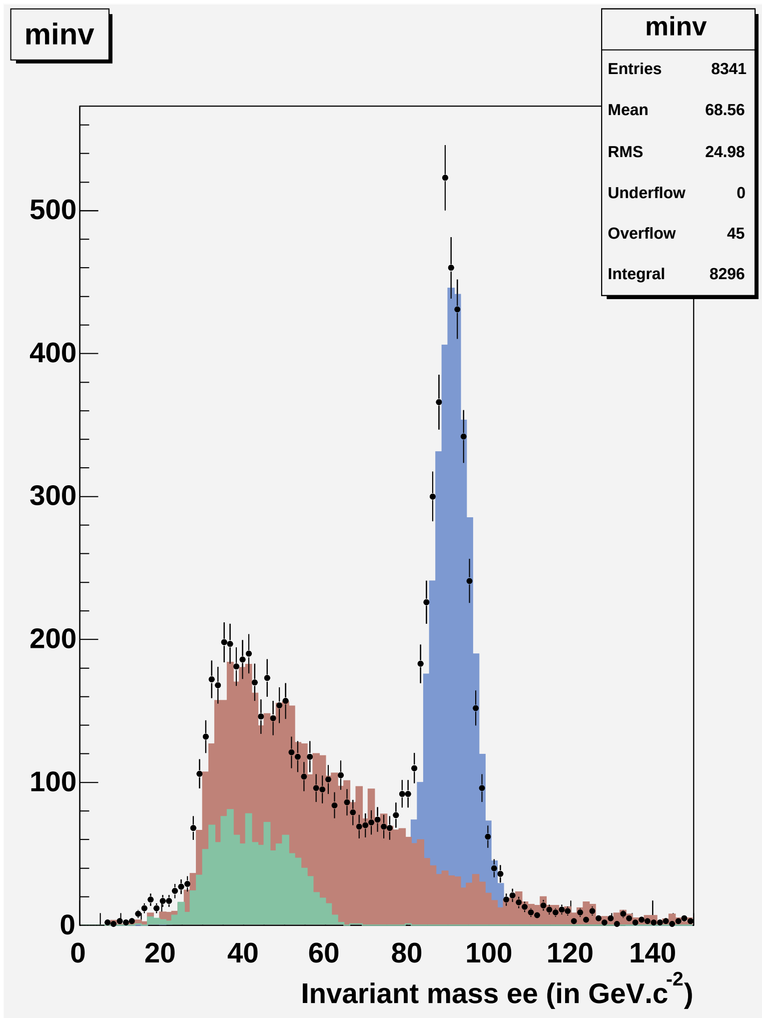

Figure 7: PRELIMINARY : QCD background study in ECCC. Distributions of “di-EM” invariant mass (at least one electron is matched). Data : points, histogram : Drell-Yan (green), Z (blue) and $\mathrm{QCD}_{bkg}(brown)$.

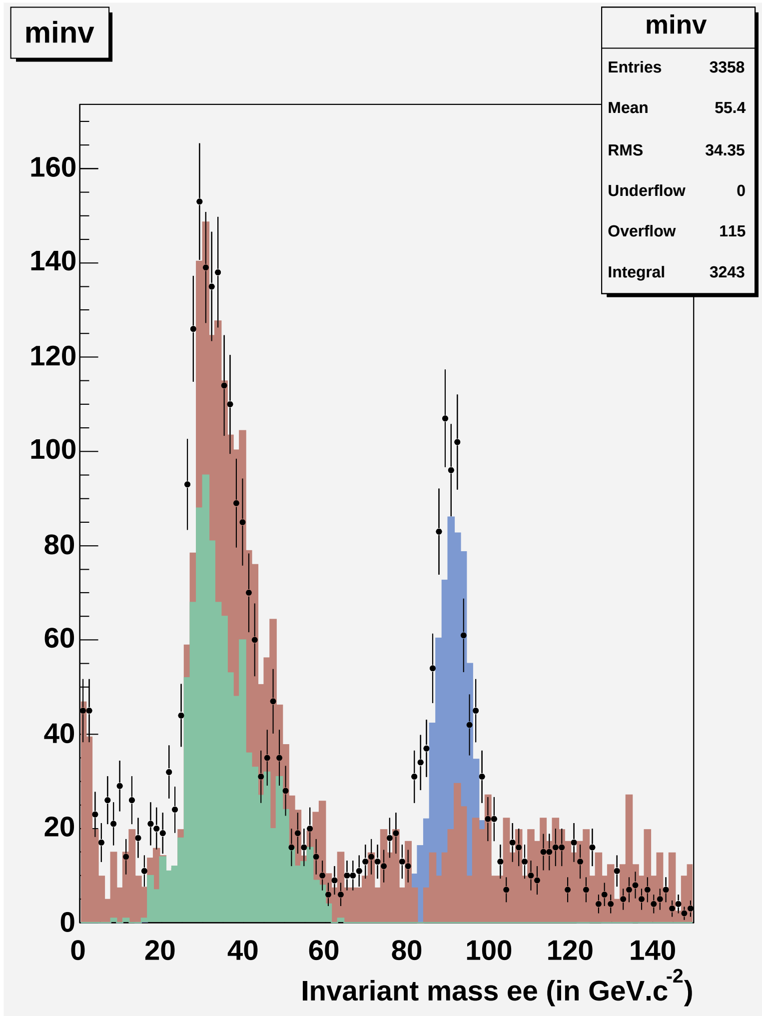

Figure 8: PRELIMINARY : QCD background study in ECEC. Distributions of "di-EM" invariant mass (at least one electron is matched). Data : points, histogram : Drell-Yan (green), Z (blue) and $\mathrm{QCD}_{bkg}(brown)$.

7 eel analysis

7.1 ee selection cuts

To control that the data are well understood, first a di-electron selection is applied and the properties of the selected events are compared to SM expectation and instrumental background. This study is done on events trigerred by a single-EM or a di-EM trigger.

The following cuts have been applied :

- at least 2 EM-candidate matched with a track ($|\mathrm{ID}| = 11$) each with HMx8 < 20.

- each EM candidate should be outside ICD region : $1.1 < |\eta| < 1.5$;
- the EM candidate should be isolated from jets (d > 0.7);
- p_T(leading EM-candidate) > 15 GeV/c;
- p_T(next to leading EM-candidate) > 10 GeV/c;

Figure 9 shows the di-EM invariant mass obtained with this selection.

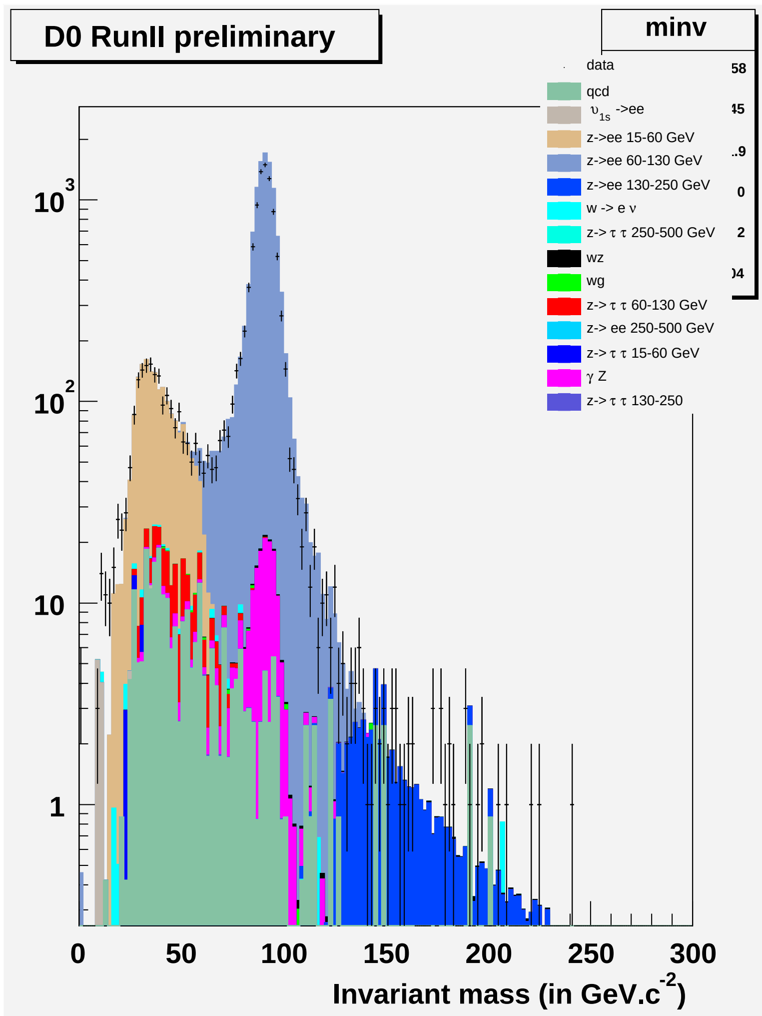

Figure 9: PRELIMINARY : Di-EM invariant mass distribution. The two EM candidates are isolated from jets, p_T leading > 15 GeV/c, p_T next to leading > 10 GeV/c and the two candidates are matched with a track.

7.2 eel selection cuts

All eel (l = e or μ) combinations are searched for in the di-EM skimmed sample (section 2). Sequential cuts are applied :

- **cut0**
  The 3 lepton candidates should fullfill the following criteria according to their nature :
  - all isolated between them $\Delta R > 0.7$;
  - electron : matched with a track (track_match_spatial_chi2prob() > 0.01), $p_T >$ 3 GeV/c, $\Delta R > 0.7$ from any jet, $|\eta| < 1.1$ or $1.5 < |\eta| < 2.5$ and HMx8 < 20 for —ID— =10 or 11;
  - muon : medium quality (isMedium()), matched with a central track, $5 < p_{TCorr} <$ 500 GeV/c, $|\eta| < 2$;
- **cut1** :
  - $P_{T1} > 15$ GeV/c,$P_{T2} > 10$ GeV/c, $P_{T3} > 3$ GeV/c/c (indices 1 refer to leading, 2 to next to leading, 3 to next-next leading);
  - electron : "is_in_eta_fiducial", hasTrackMatch, —dcar— < 0.2, —dcaz— < 0.6;
  - muon : —dca— < 0.16,
- **cut2** : 80 < invariant mass of the 2 leading ee < 100 GeV/c^2

Numbers of data and expected events are given in Table 7. Processes which give no event after cut0 are not mentioned in the table ($\gamma^*/Z \to ee$ (2 - 15), $\gamma^*/Z \to \tau\tau$ (15 - 60, above 130), W $\to e\nu$, W $\gamma \to \gamma e\nu$).

Figures 10, 11, 12 , show the ee invariant mass after application of the sequential cuts. Table 7 gives the number of events in data or expected from the SM or QCD background. After all those cuts, 3 events remain. The main characteristics of those events are given in the Table 8.

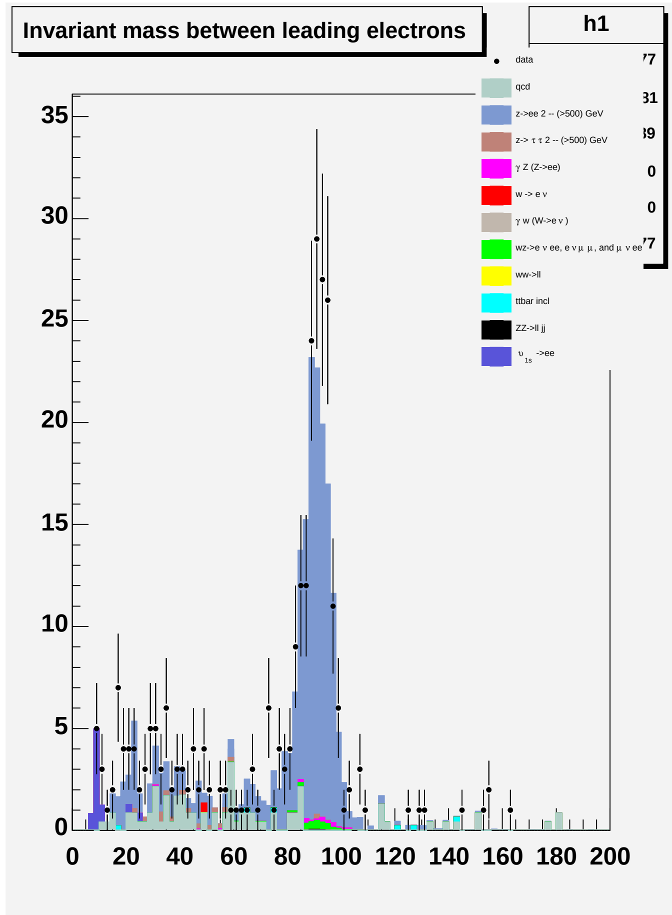

Figure 10: PRELIMINARY : invariant mass distribution of the two leading ee of the eel candidates after cut0 (GeV/c^2)

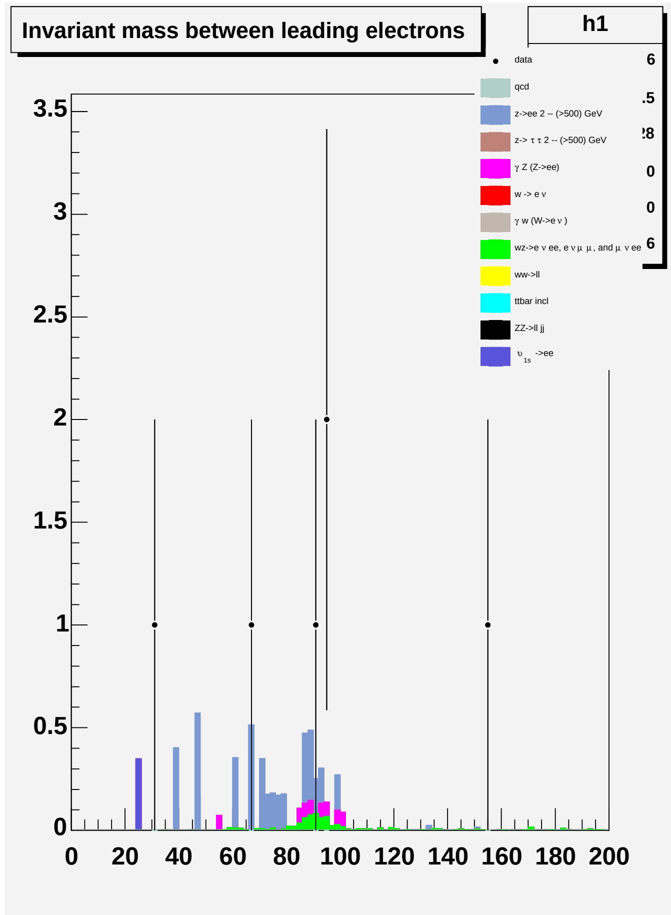

Figure 11: PRELIMINARY : invariant mass distribution of the two leading ee of the eel candidates after cut1 (GeV/c^2)

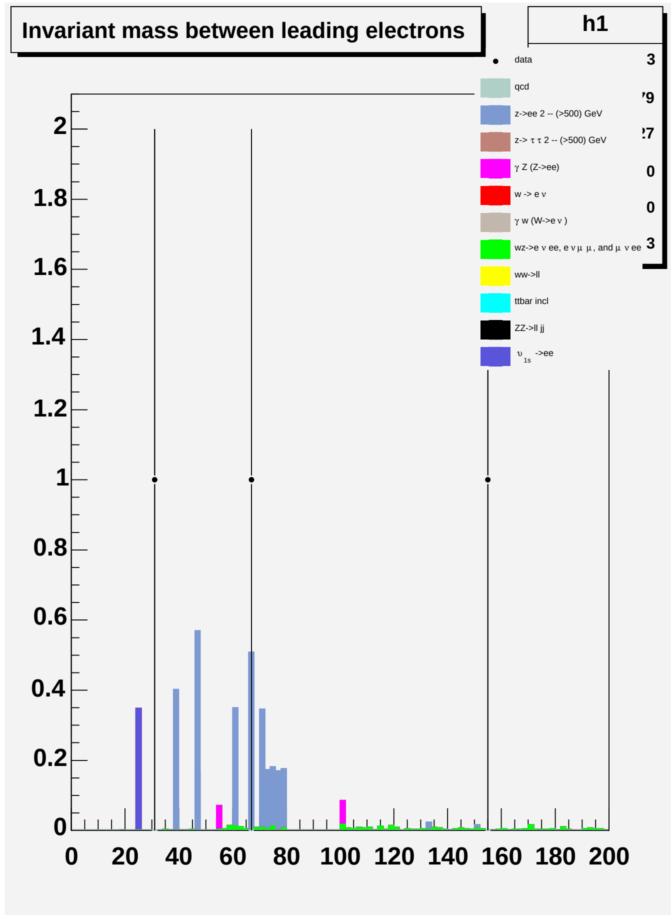

Figure 12: PRELIMINARY : invariant mass distribution of the two leading ee of the eel candidates after cut2 (GeV/c^2)

Process	cut0	cut1	cut2
$\gamma^*/Z \to ee$ (15 – 60)	27.6 ± 5.3	0.8 ± 0.6	0.8 ± 0.6
$\gamma^*/Z \to ee$ (60 –130)	151.9 ± 22.6	3.2 ± 0.9	2.03 ± 0.66
$\gamma^*/Z \to ee$ (130 – 250)	1.2 ± 0.2	0.04 ± 0.02	0.04 ± 0.02
$\gamma^*/Z \to ee$ (250 – 500)	0.14 ± 0.02	0.004 ± 0.002	0.004 ± 0.002
$\gamma^*/Z \to ee$ (above 500)	0.005 ± 0.001	0.00004 ± 0.00005	0.00004 ± 0.00005
$\gamma^*/Z \to \tau\tau$ (60 – 130)	3.5 ± 1.0	0	0
$Z\gamma \to \gamma ee$	1.6 ± 0.4	0.56 ± 0.21	0.13 ± 0.10
WW W $\to e\nu$ and $\mu\nu_\mu$ $WW \to ll \to \tau+$ X	0.29 ± 0.03	0.002 ± 0.001	0.001 ± 0.001
WZ W $\to e\nu$ and $\mu\nu_\mu$ Z $\to ee$ and $\mu\mu$	10.3 ± 0.9	2.9 ± 0.3	1.44 ± 0.17
$ZZ \to lljj$	0.32 ± 0.15	0.004 ± 0.002	0.0005 ± 0.0005
$t\bar{t}$ *incl*	1.39 ± 0.60	0	0
$\Upsilon \to ee$	1.13 ± 0.41	0.05 ± 0.07	0.05 ± 0.07
QCD	36.9 ± 7.37	0	0
total bkg	236.9 ± 24.4	7.6 ± 1.1	4.5 ± 0.9
DATA	277	7	3

Table 7: PRELIMINARY: Number of Data events and of expected background events after each cut of the eel selection. The errors include trigger, cross section and luminosity sytematic errors

	event 1	event 2	event 3
Runnum	167886	166505	163976
Eventnum	24252142	42938126	7343710
type	eee	eee	eee
p_T leptons	68.3, 60.9, 33.4	32.7, 14.6, 3.4	30.2, 20.5, 14.7
η_T leptons	0.39, -0.9, -0.05	0.54, 0.89, 0.22	0.88, 2.51, 2.40
ϕ leptons	5.5, 1.9, 3.1	1.4, 6.14, 2.37	2.08, 5.58, 4.67
charge leptons	- + +	+ - -	- + +
MET (GeV)	10.8	4.8	10.4
Number of jets p_T, η, ϕ	0	1 19.5, 0.1, 4.34	0
M_{ee} 1-2, 2-3, 3-1	155.9, 66.5, 90.9	31.8, 14.2, 10.1	66.7, 15.3, 53.7

Table 8: PRELIMINARY: Main characteristics of the eel candidates.

8 Systematic errors

8.1 Systematic error due to the luminosity

The relative error on the luminosity is estimated at 5% and has been included in the errors of Table 7.

8.2 Systematic error due to Trigger

To be estimated

8.3 Systematic error due to MC cross sections

The relative systematic errors due to cross section are for SM processes deduced from Table 1 and included in the errors of Table 7.

9 Cross sections limits at 95% CL and discussion of the results

The efficiency of the present RpV SUSY analysis with λ_{121} is presented in Table 9 for $m_0 = 250$ GeV/c^2, tan$\beta = 5$ and $\mu < 0$ and $\mu > 0$. These efficiencies include the offline EMID and MUID reconstruction efficiencies as well as track matching factors mentioned in subsections 4.2 and 4.3.

$m_{1/2}$ GeV/c^2	$\mu < 0$ cut0	$\mu < 0$ cut1	$\mu < 0$ cut2	$\mu > 0$ cut0	$\mu > 0$ cut1	$\mu > 0$ cut2
225				0.238 ± 0.016	0.097 ± 0.008	0.083 ± 0.007
220				0.240 ± 0.016	0.103 ± 0.009	0.090 ± 0.008
215				0.234 ± 0.016	0.098 ± 0.009	0.087 ± 0.008
210				0.232 ± 0.016	0.102 ± 0.009	0.092 ± 0.008
205				0.227 ± 0.016	0.098 ± 0.009	0.085 ± 0.007
200				0.224 ± 0.016	0.095 ± 0.008	0.083 ± 0.007
195	0.206 ± 0.014	0.083 ± 0.007	0.071 ± 0.006	0.225 ± 0.015	0.094 ± 0.008	0.083 ± 0.007
190	0.208 ± 0.014	0.081 ± 0.007	0.071 ± 0.006	0.222 ± 0.015	0.093 ± 0.008	0.082 ± 0.007
185	0.198 ± 0.014	0.080 ± 0.007	0.071 ± 0.006	0.253 ± 0.032	0.136 ± 0.024	0.131 ± 0.024
180	0.197 ± 0.014	0.077 ± 0.007	0.067 ± 0.006	0.212 ± 0.015	0.089 ± 0.008	0.079 ± 0.007
175	0.202 ± 0.014	0.080 ± 0.007	0.070 ± 0.006	0.208 ± 0.015	0.087 ± 0.008	0.078 ± 0.007
170	0.191 ± 0.013	0.077 ± 0.007	0.068 ± 0.006	0.214 ± 0.015	0.091 ± 0.008	0.081 ± 0.007
165	0.187 ± 0.014	0.070 ± 0.007	0.065 ± 0.006	0.201 ± 0.014	0.080 ± 0.007	0.073 ± 0.006
160	0.190 ± 0.013	0.072 ± 0.006	0.064 ± 0.006			
155	0.184 ± 0.013	0.071 ± 0.006	0.064 ± 0.006			

Table 9: PRELIMINARY: Efficiencies and their error for the SUSY points generated with $m_0 = 250$ GeV/c^2 tan$\beta = 5$.

A Bayesian 95 % CL Poisson limit has been computed using the root macro written by G. Landsberg [14]. Among the inputs are the efficiency on the signal (and its error) and the number of background events (and its error). The relative uncertainty on the efficiency $\times$ acceptance for the signal (including the luminosity error and the systematic errors due to cross section only for the number of background events) is computed as :

$$(d\epsilon/\epsilon)^2 =$$
$$(d\epsilon_{sel}/\epsilon_{sel})^2 + (d\epsilon_{match1}/\epsilon_{match1})^2 + (d\epsilon_{emid1}/\epsilon_{emid1})^2 + (d\epsilon_{match2}/\epsilon_{match2})^2 + (d\epsilon_{emid2}/\epsilon_{emid2})^2 +$$
$$(d\epsilon_{match3}/\epsilon_{match3})^2 + (d\epsilon_{emid3}/\epsilon_{emid3})^2 + (d\epsilon_{lumi}/\epsilon_{lumi})^2 + (d\epsilon_{\sigma}/\epsilon_{\sigma})^2 + (d\epsilon_{trig}/\epsilon_{trig})^2$$

where ϵ_{sel}, ϵ_{eid}, ϵ_{match} and ϵ_{lumi} are the selection, matching and emid efficiencies respectively

For each fully simulated point at $m_0 = 250$ GeV/c^2, tanβ=5, the limit on σ at 95 % CL are given given in Table 10 as well as the cross section calculated with PROSPINO ($\sigma_{PROSPINO}$).

$m_{1/2}$ GeV/c^2	$\mu < 0$ σ_{95} Poisson pb	$\mu < 0$ $\sigma_{PROSPINO}$ pb		$\mu > 0$ σ_{95} Poisson pb	$\mu > 0$ $\sigma_{PROSPINO}$ pb
225				0.349	0.266
220				0.320	0.306
215				0.331	0.352
210				0.315	0.404
205				0.317	0.464
200				0.345	0.532
195	0.406	0.305		0.345	0.627
190	0.410	0.338		0.348	0.717
185	0.407	0.391		0.239	0.846
180	0.435	0.439		0.362	0.998
175	0.403	0.502		0.369	1.139
170	0.421	0.596		0.358	1.331
165	0.453	0.673		0.394	1.600
160	0.455	0.780			
155	0.455	0.875			

Table 10: PRELIMINARY: Upper limit on σ at 95% CL for the SUSY points generated with $m_0 = 250$, tan$\beta = 5$ and comparison with SUSY cross sections obtained with PROSPINO ($\sigma_{PROSPINO}$.

Figures 13 and 14 show the σ_{95} limit and the $\sigma_{PROSPINO}$ (NLO) cross sections for both signs of μ as a function of $m_{1/2}$ and for a Poisson calculation.

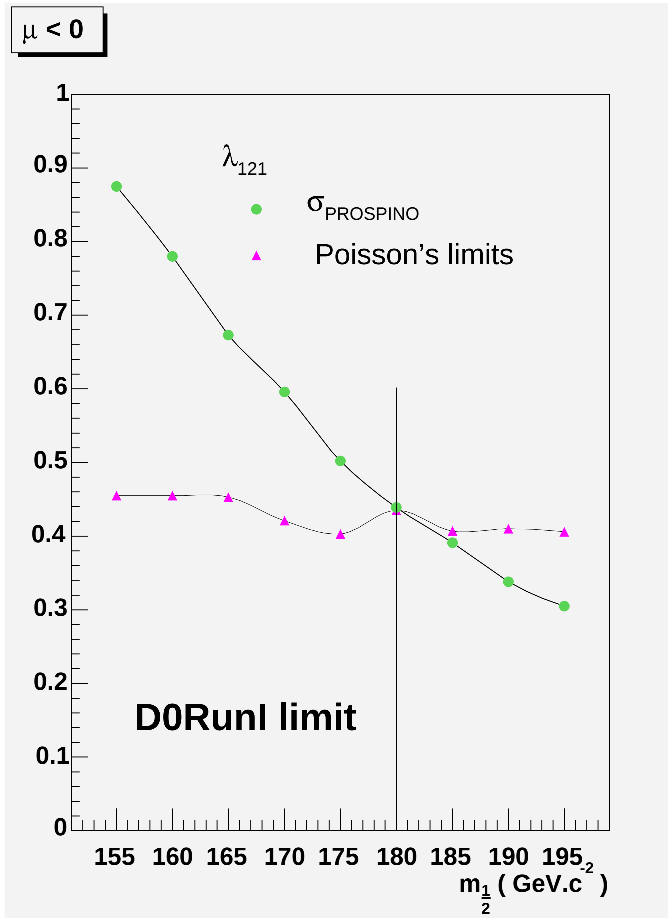

Figure 13: PRELIMINARY : σ_{95} limit and σ_{SUSY} cross section for $\mu < 0$ as a function of $m_{1/2}$ and for a Poisson or a Gaussian calculation

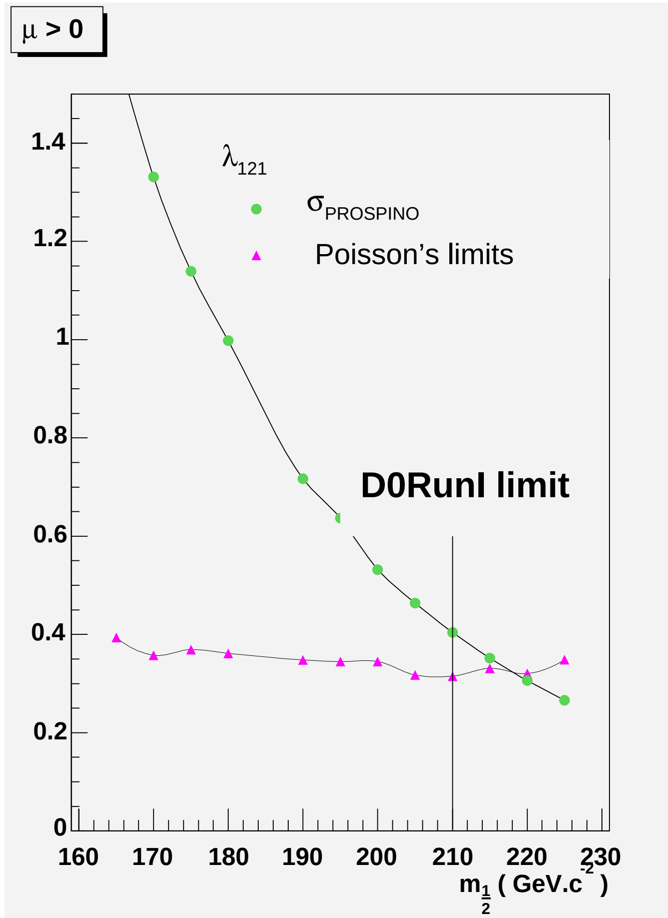

Figure 14: PRELIMINARY : σ_{95} limit and σ_{SUSY} cross section for $\mu > 0$ as a function of $m_{1/2}$ and for a Poisson or a Gaussian calculation

The 95 % CL RunI limits [16] for $m_0 = 250$ GeV/c^2 tan$\beta = 5$ are :
for $\mu < 0$: $m_{1/2} > 180$ GeV/c^2
for $\mu > 0$: $m_{1/2} > 210$ GeV/c^2

Present preliminary results are at the same level of sensitivity.

10 Conclusions

A preliminary search for tri-electron events in 176 ± 9 pb^{-1} of data recorded by D0 from September 2002 to January 2004 has been performed in the framework of RpV SUSY in the hypothesis of a λ_{121} coupling. 3 events have been selected for 4.5 ± 0.9 expected from SM physics processes and instrumental background. Preliminary study of the exclusion domain in the mSUGRA parameter space shows that for m_0 =250 GeV/c^2 tanβ =5, $m_{1/2} < 180$ GeV/c^2 (poisson) are excluded at 95% CL for $\mu < 0$ and $m_{1/2} < 216$ GeV/c^2 (poisson) are excluded at 95% CL for $\mu > 0$. Those limits are at the same level of sensitivity than D0 RunI limits.

11 Acknowledgements

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References

[1] S. Protopopescu, S. Baffioni, E. Nagy, DØ Note 3979 (04/2002), *ThumbNail: a compact data format*

[2] Common Sample Group http://www-d0.fnal.gov/Run2Physics/cs/

[3] G. Altarelli, R.K. Ellis and G. Martinelli Nucl. Phys. B157 461 (1979).

[4] T. Sjostrand, Comp. Phys. Commun. **82** (1994) 74 CERN-TH 7112/93 (1993)

[5] N.Ghodbane, S. Katsanevas, P. Morawitz, E. Perez, *Susygen 3.00/43* http://lyoinfo.in2p3.fr/susygen/susygen3.html http://www-d0.fnal.gov/computing/MonteCarlo/generators/susygen.html

[6] A. Djouadi, J-L. Kneur and G. Moultaka, hep-ph/0211331, (2002), *Suspect : a Fortran Code for the Supersymmetric and Higgs Particle Spectrum in the MSSM*

[7] V. Bednyakov, A. Faessler and S. Kovalenko, hep-ph/9904414, (1999), *On present status of R-parity violating supersymmetry*

[8] emid certification http://www-d0.fnal.gov/phys_id/emid/d0_private/certification/welcome.html

[9] http://www-d0.fnal.gov/computing/algorithms/muon/p14muon_v02.ps

[10] http://www-clued0.fnal.gov/˜hohlfeld/winter2004/

[11] http://www-d0.fnal.gov/computing/algorithms/calgo/met/met_cor_doc.html

[12] M. Paterno, DØ Note 2861 (2/26/1996), *Calculating Efficiencies and Their Uncertainties.*

[13] T. Sjostrand, Comp. Phys. Commun. **82** (1994) 74
CERN-TH 7112/93 (1993)

[14] G. Landsberg, *Bayesian 95 % CL limit calculator for Gaussian or Poisson statistics. Root macro for NP analysis*

[15] http://www-d0.fnal.gov/d0dist/dist/packages/PROSPINO/
Cross sections have been computed with susy_tools written by Steve Muanza :
http://www-d0.fnal.gov/d0dist/dist/packages/susy_tools/devel/doc/README.txt

[16] D0 Collaboration, B. Abbott *et al.*, Phys. Rev. D62 (2000) 071701