Search for R-parity violating Supersymmetry at DØ

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R-parity

- discrete quantum number:

  $R = (-1)^{3B+L+2S}$, B - baryon nb, L - lepton nb, S - spin

  ⇨ R = +1 for SM particle

  ⇨ R = -1 for SUSY particle

- R-parity violation terms compatible with all superpotential symmetries:

$$W_{\not{R}p} = \lambda_{ijk} L_i L_j E^c_k + \lambda'_{ijk} L_i Q_j D^c_k + \lambda''_{ijk} U^c_i D^c_j D^c_k$$

  ⇨ 45 new Yukawa couplings

- R-parity conservation is to suppress $\Delta L \neq 0$ and $\Delta B \neq 0$ processes
- but R-parity violation cannot be excluded

R-parity Violation

- experimental consequences of $\not{R}_p$:
  - B and/or L violation
  - LSP can decay with or without displaced vertices
  - sparticles can be produced resonantly
- usual search hypothesis:
  - mSUGRA with $\tilde{\chi}_1^0$ as LSP and $\not{R}_p$
  - only one $\not{R}_p$ coupling dominates
  - if $\not{R}_p$ coupling large enough, resonant production
  - otherwise pair production

resonant production: di-□ channel in Run 1

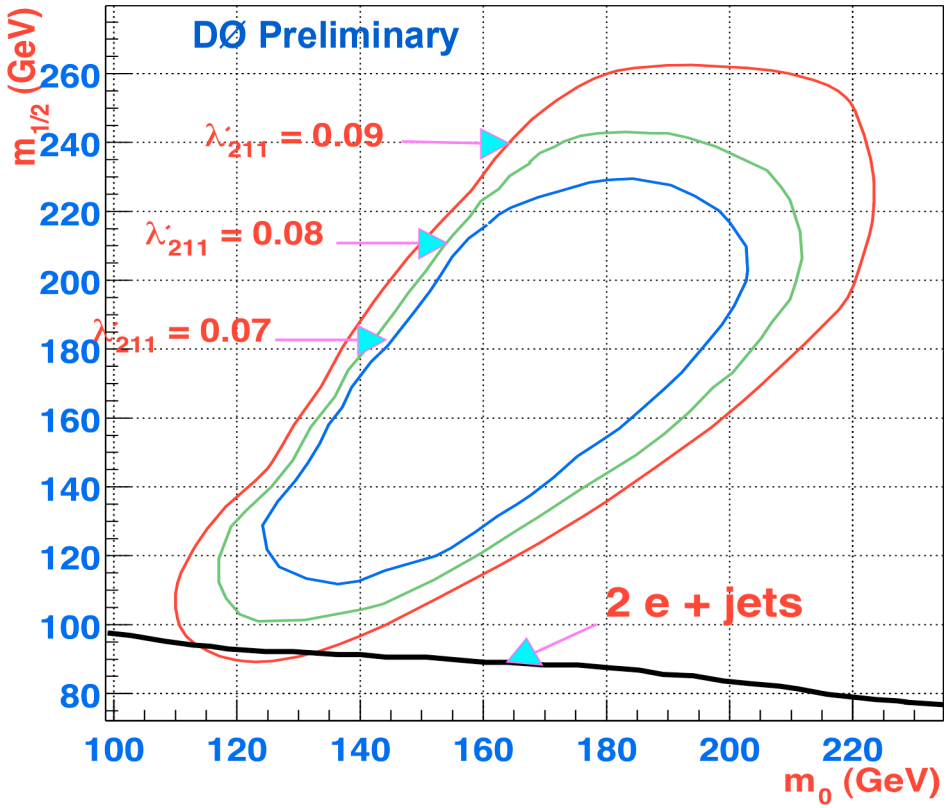
DØ Preliminary

- dominant coupling: λ'_{211}

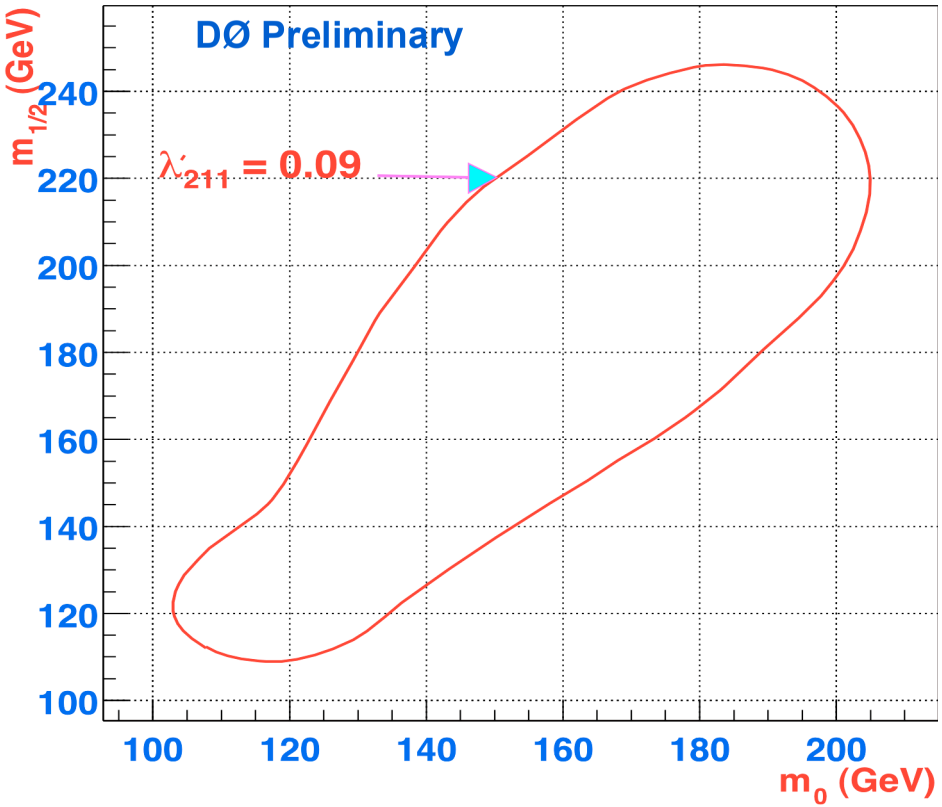
⇨ resonant □ or λ'_{211} production

- channel: ≥ 2 muons and ≥ 2 jets
- background: Drell-Yan, tt, Z + 2 jets, WW + jets

$A_0 = 0$, □ < 0, tan□ = 2



$A_0 = 0$, □ < 0, tan□ = 5



pair production: di-e channel in Run 1

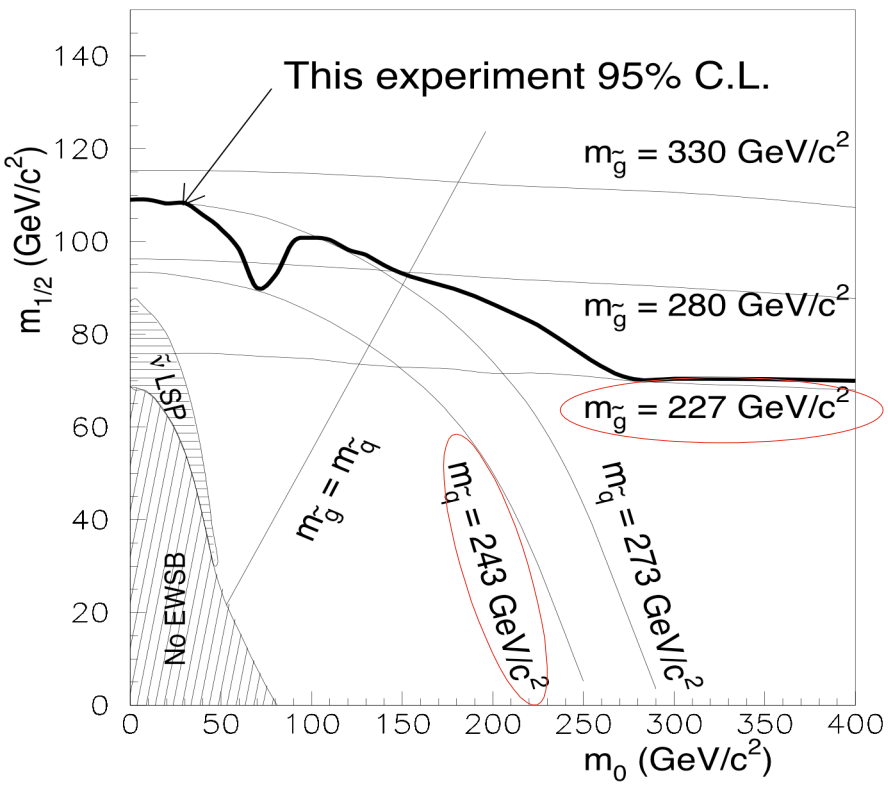
Phys. Rev. Lett. {83}, 4476 (1999)

- all pair production processes considered
- one dominant coupling: λ'_{1jk} (j=1,2; k=1,2,3)

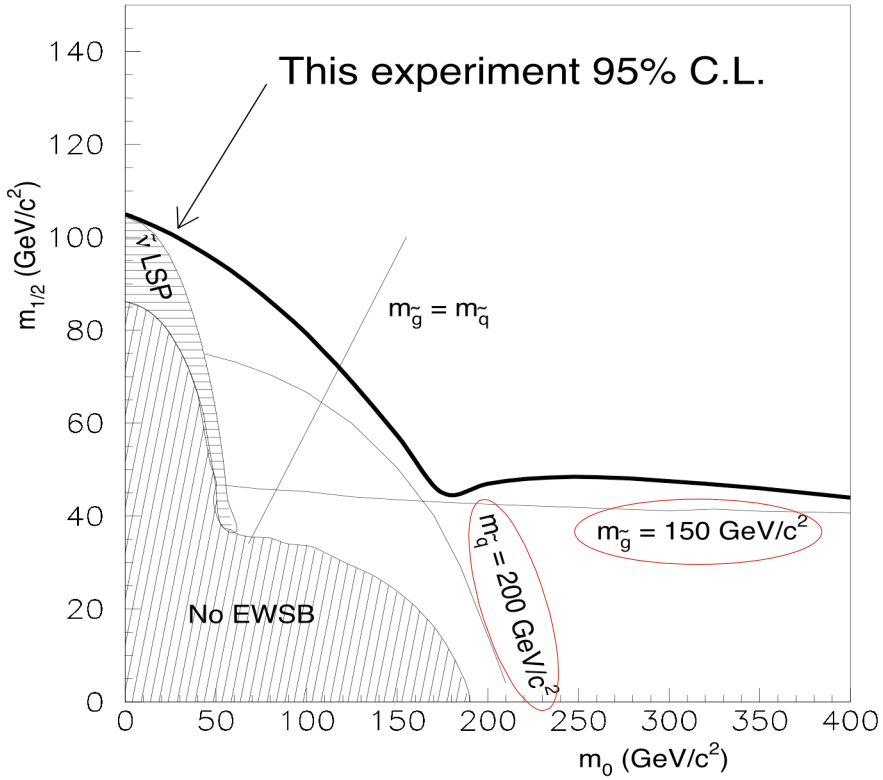
⇨ LSP decays to 1 electron and 2 jets

- channel: $\geq$ 2 electrons and $\geq$ 4 jets
- background: Drell-Yan, tt, Z→ $\tau\tau$→ ee, misidentification of jets as electrons

$A_0 = 0$, $\mu < 0$, $\tan\beta = 2$



$A_0 = 0$, $\mu < 0$, $\tan\beta = 6$

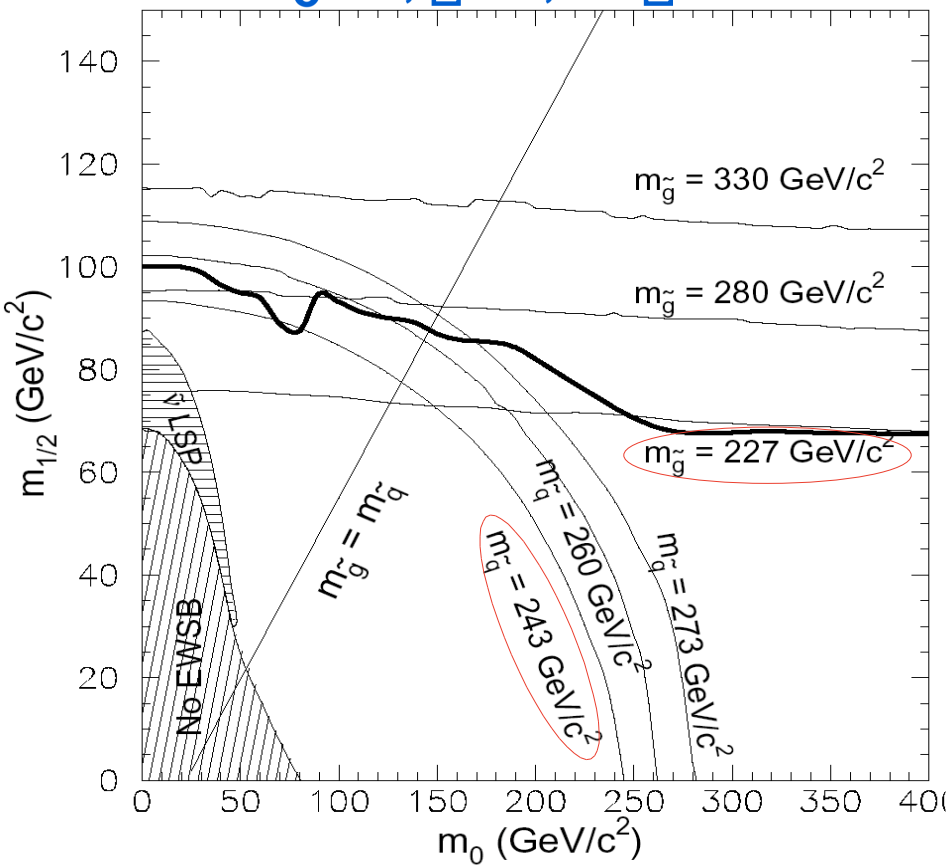


pair production: di-□ channel in Run 1

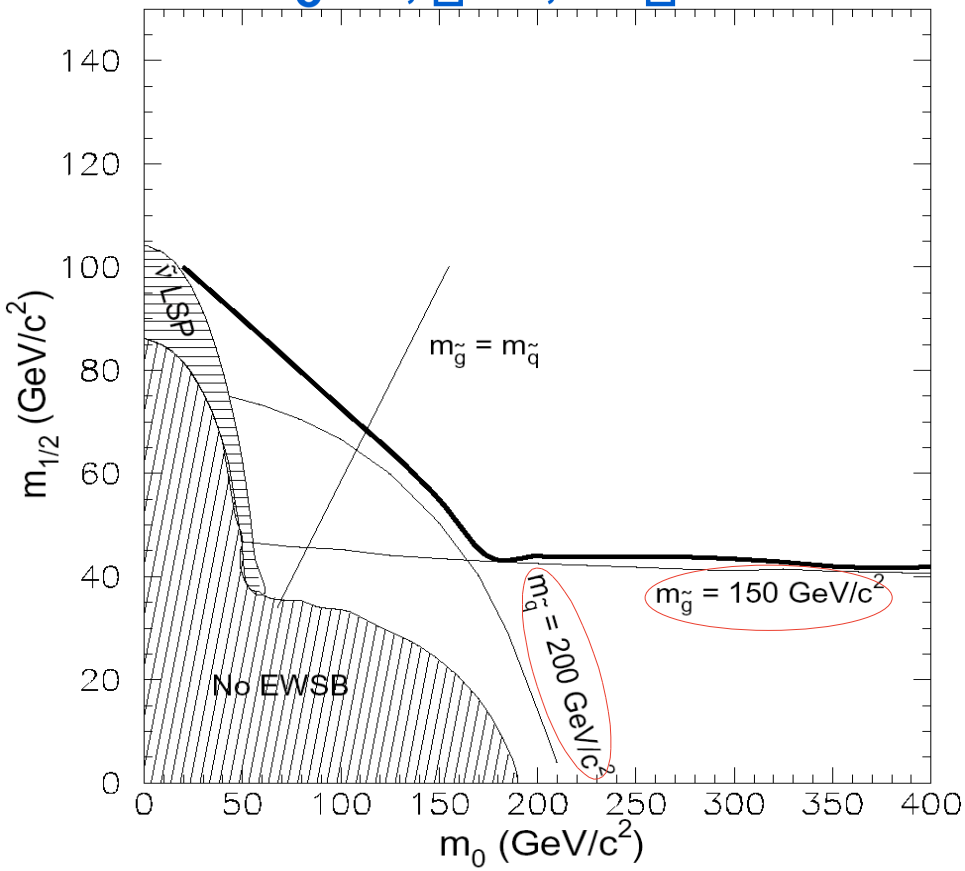
hep-ex/0111053

- all pair production processes considered
- dominant coupling: same analysis as previous with a dominant $\not{\Pi}_{2jk}$
- channel: ≥ 2 muons and ≥ 4 jets
- background: (Drell-Yan, tt, Z→□□, Z→ □□→ □□, WW→□□) + jets

$A_O = 0$, □ < 0, tan□ = 2



$A_O = 0$, □ < 0, tan□ = 6

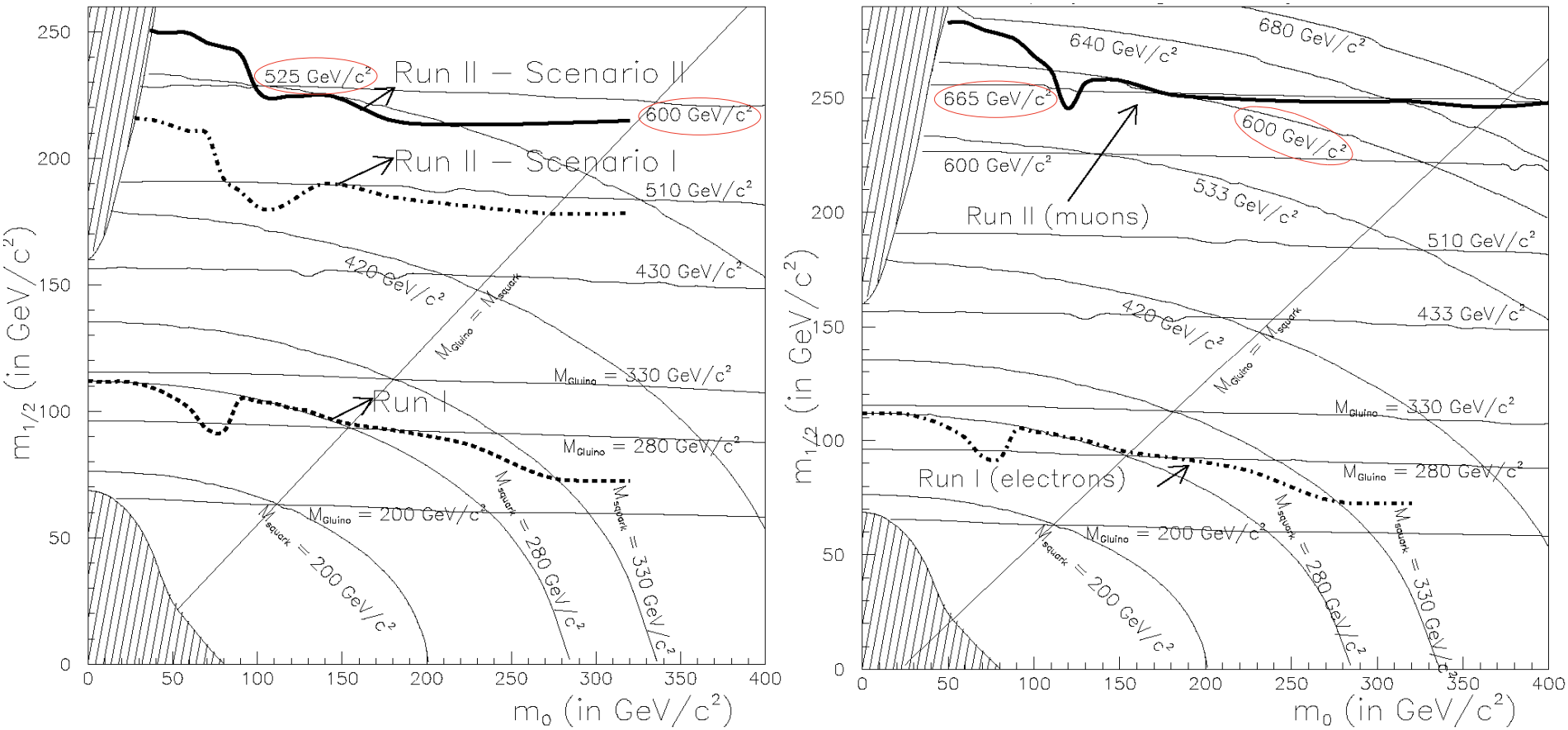


pair production: dilepton channel in Run 2a

hep-ph/9906224

⇨ $\mathcal{L}_{int}$ = 2 fb^{-1}

di-e channel **A_0 = 0, μ < 0, tanβ = 2** *di-μ channel*



⇨ **Scenario I: improvement due to $\mathcal{L}_{int}$**

⇨ **Scenario II: improvement due to $\mathcal{L}_{int}$ + detector upgrade**

pair production: trilepton channel in Run 1

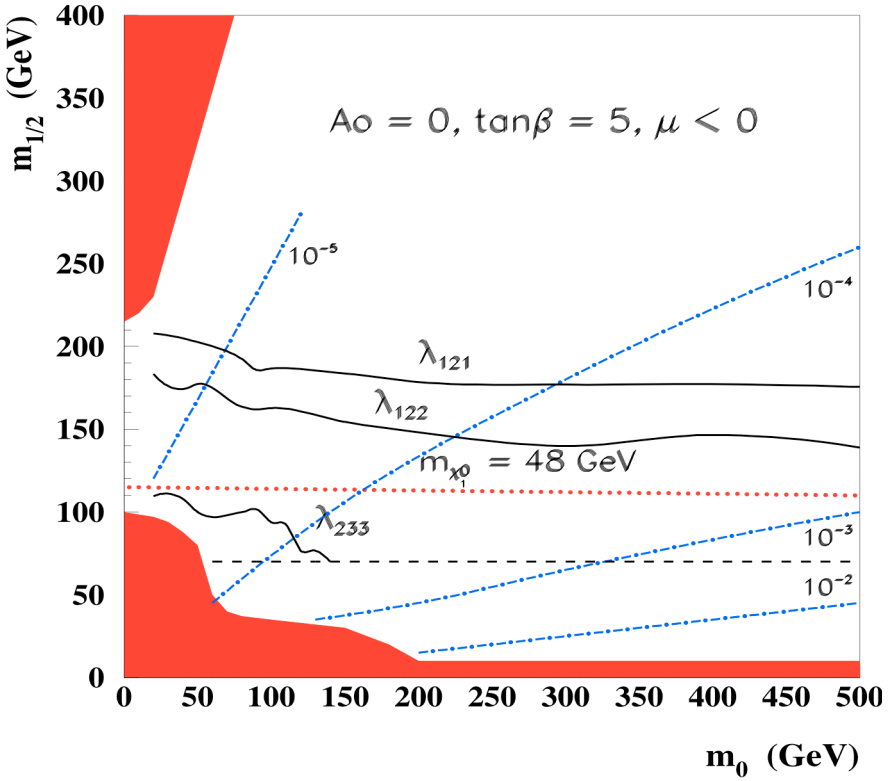
Phys. Rev. D Rapid. Comm. {62}, 071701 (2000)

- all pair production processes considered
- dominant coupling: one of the three (λ_{121}, λ_{122}, λ_{233})

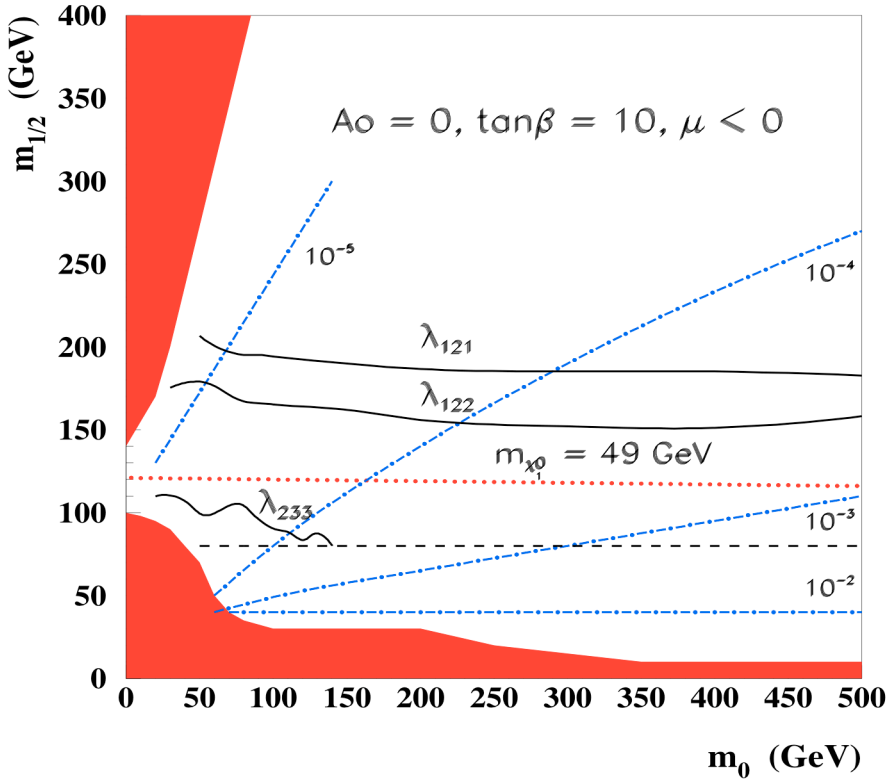
⇨ LSP decays to 2 leptons and 1 neutrino

- channel: eee, ee□, e□□, □□□
- background: Drell-Yan, ZZ, misidentification of jets as electrons

$A_0 = 0$, □ < 0, tan□ = 2

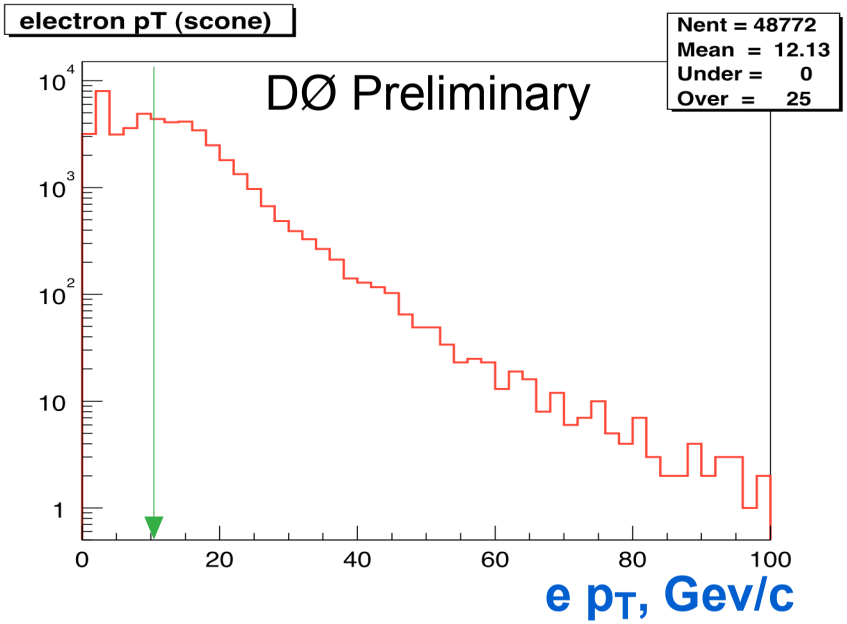


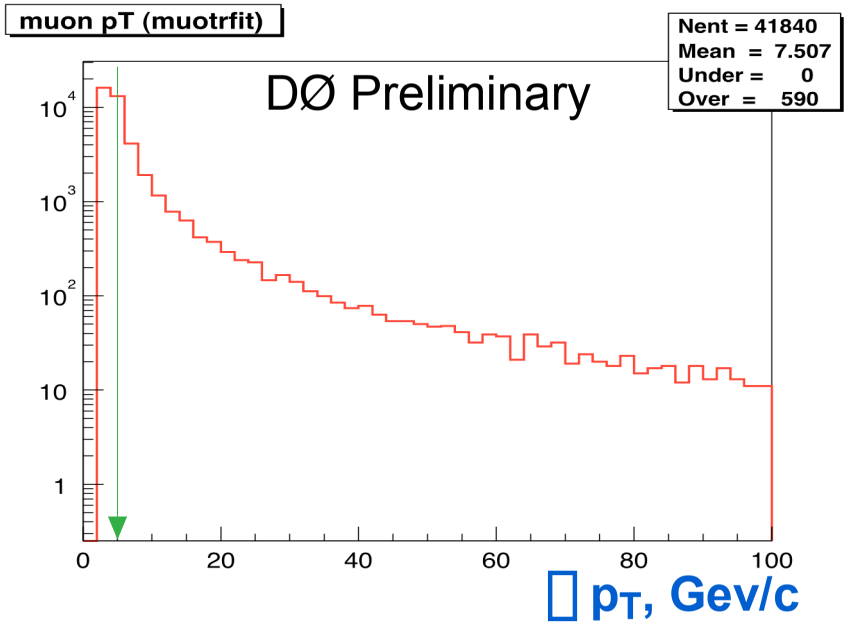
$A_0 = 0$, □ < 0, tan□ = 10



pair production: trilepton channel in Run 2

- **search's started: $\mathcal{L}_{int}$ ~ 10 pb^{-1} (~10% of Run 1)**





- **Lepton cuts:**
  - **em-particle p_T > 10 GeV/c**
  - **muon p_T > 5 GeV/c**
- **Number of events after selection:**

evt type	e + e + e	e + e +	e + +	+ +
num. of evts	5	4	2	1

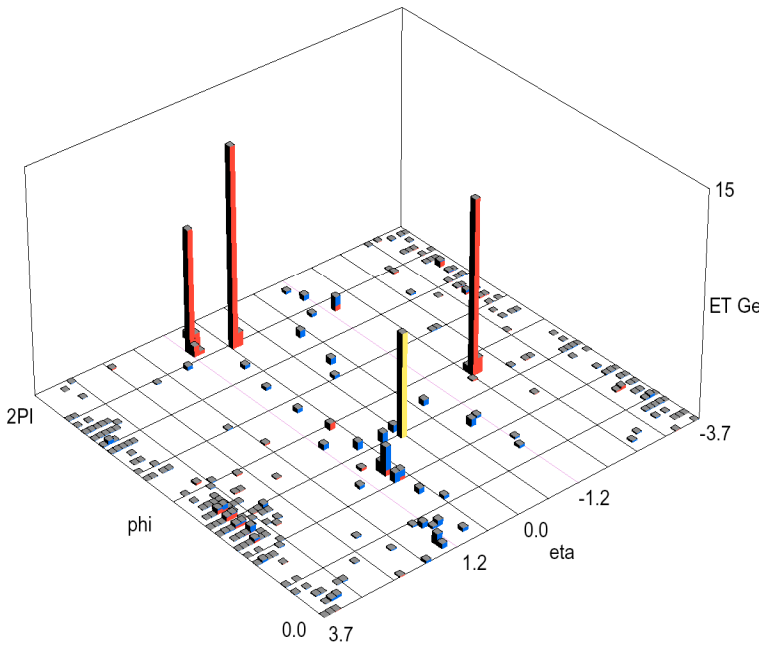
- **Background study is in progress**

pair production: trilepton channel in Run 2

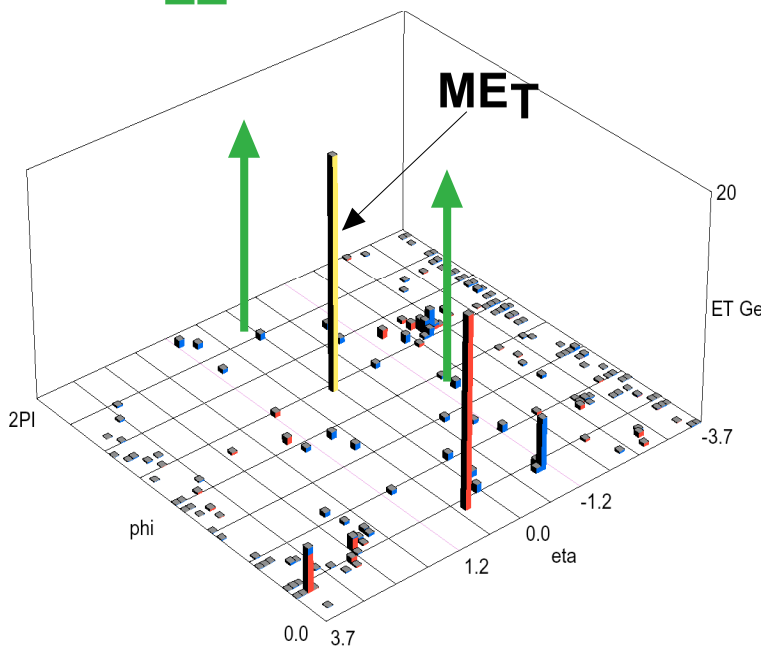
DØ Preliminary

- **example of candidates:**

eee candidate event



e□□ candidate event



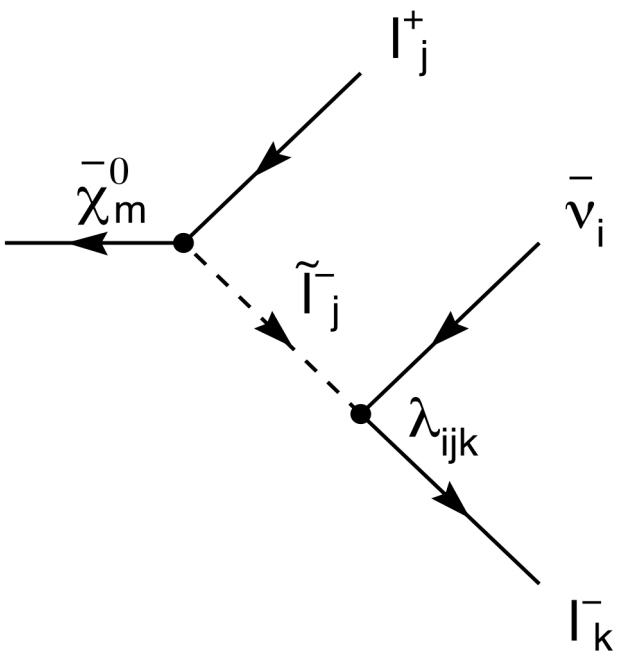
e_1	e_2	e_3
p_T(cal) = 17.9 □ = 0.43 □ = 5.42 charge = +1	p_T(cal) = 13.9 □ = -1.94 □ = 2.8 charge = +1	p_T(cal) = 13.2 □ = 1.06 □ = 5.72 charge = -1
m_{e1e2} = 55.7	m_{e1e3} = 10.8	m_{e2e3} = 63.5
m_{e1e2e3} = 85.2 GeV/c^2		ME_T = 10.9 GeV

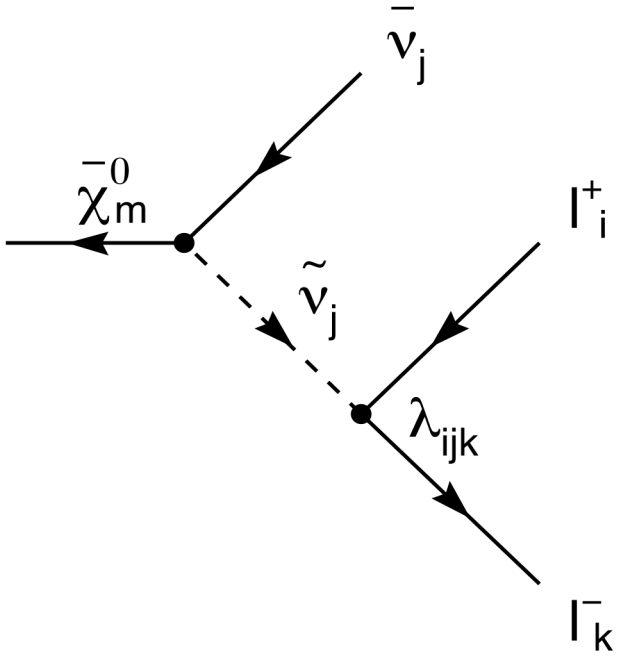
e	□1	□2
p_T(cal) = 19.2 □ = 0.40 □ = 0.63 no track match	p_T = 28.2 □ = -0.10 □ = 6.20 charge = -1	p_T = 9.82 □ = -1.48 □ = 2.88 charge = +1
	me1e2 = 55.7	
ME_T = 31.8 GeV		

Conclusion

- DØ searches for R-parity violation in Run 1:
  - ⇨ large number of $\not{R}_p$ couplings explored
    - ➡ No sign of $\not{R}_p$ SUSY found
- Run 2 will provide a wide range of improvements:
  - ⇨ ~20× more luminosity (2004)
  - ⇨ 10% more energy
  - ⇨ improved detector
  - ⇨ improved identification capabilities for **e**, □, □ (very important for high tan□ searches)
    - ➡ large increase on $\not{R}_p$ coupling and mass sensitivity
    - ➡ great discovery potential for Tevatron

Diagrams


l^+_j
$\bar{\chi}^0_m$
$\bar{\nu}_i$
$\tilde{l}^-_j$
λ_{ijk}
l^-_k


$\bar{\nu}_j$
$\bar{\chi}^0_m$
l^+_i
$\tilde{\nu}_j$
λ_{ijk}
l^-_k