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R-parity Violation and SUSY Searches at the LHC

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OUTLINE

- **R-parity Violation** equally well motivated **R-Parity Conservation**
- **Should** dedicate comparable effort at the LHC
- What has been done?
- Top 10 R-parity Violating LHC Signatures
  (work in progress: Ben Allanach, Tim Stefaniak, Werner Porod, Florian Staub)

SUSY LAGRANGIAN

- SUSY Lagrangian fixed by
  - gauge group: SU(3)xSU(2)xU(1)
  - particle content: $L_i,\ \bar{E}_i,\ Q_i,\ \bar{U}_i,\ \bar{D}_i,\ H_u,\ H_d$
    (chiral superfields)

$$L = \begin{pmatrix} N \\ E \end{pmatrix}_L \sim \begin{pmatrix} \phi_{\tilde{\nu}} + \epsilon\psi_\nu \\ \phi_{\tilde{e}} + \epsilon\psi_e \end{pmatrix}_L, \quad E^c \sim \phi^*_{\tilde{e}} + \epsilon\psi^c_{e_R}$$

$$Q = \begin{pmatrix} U \\ D \end{pmatrix}_L \sim \begin{pmatrix} \phi_{\tilde{u}} + \epsilon\psi_u \\ \phi_{\tilde{d}} + \epsilon\psi_d \end{pmatrix}_L, \quad U^c \sim \phi^*_{\tilde{u}} + \epsilon\psi^c_{u_R}, \quad D^c \sim \phi^*_{\tilde{d}} + \epsilon\psi^c_{d_R}$$

  - Superpotential $\longrightarrow$

SUPERPOTENTIAL

$$\boxed{W_{\text{MSSM}} = (h_e)_{ij}\, L_i H_d E_j^c + (h_d)_{ij}\, Q_i H_d D_j^c + (h_u)_{ij}\, Q_i H_u U_j^c + \mu H_d H_u}$$

- These terms give mass to quarks and leptons.

$$\boxed{W_{\text{RPV}} = \underbrace{\lambda_{ijk} L_i L_j \overline{E}_k + \lambda'_{ijk} L_i Q_j \overline{D}_k + \kappa_i L_i H_u}_{\text{Lepton Number Violating}} + \underbrace{\lambda''_{ijk} \overline{U}_i \overline{D}_j \overline{D}_k}_{\text{Baryon Num. Viol.}}}$$

- Do you only consider W_{MSSM} or include some or all of W_{RPV}?

R-Parity MSSM

Advantages:

- Proton stable (Well should really consider P_6 instead of R_p)
- Automatic dark matter candidate: $\tilde{\chi}_1^0$

Disadvantages:

- Must add ν_R and Majorana scale $\mathrm{M_M} > 10^{11}\,\mathrm{GeV}$
- No solution to strong CP problem

R-Parity MSSM & Axion

Advantages:

- Proton stable (Well should really consider P_6 instead of R_p)
- Automatic dark matter candidate: $\tilde{\chi}_1^0$
- Peccei Quinn axion solution to strong CP problem

Disadvantages:

- Must add ν_R and Majorana scale $\mathrm{M_M} > 10^{11}\,\mathrm{GeV}$
- Not observed to date

Baryon Triality (B_3) SSM

- $W = W_{\mathrm{MSSM}} + \lambda_{ijk} L_i L_j \overline{E}_k + \lambda'_{ijk} L_i Q_j \overline{D}_k + \kappa_i L_i H_u$

Advantages:

- Proton stable
- Automatic light neutrino masses
  - $\kappa L H_u \Longrightarrow \nu_i$ and $\tilde{\chi}_j^0$ mix $\Longrightarrow$ 1 massive neutrino
  - at 1–loop ($LL\bar{E}$, $LQ\bar{D}$) generate other neutrino masses

Disadvantages:

- No dark matter candidate
- No solution to strong CP problem

B_3 SSM & Axion

- $W = W_{\mathsf{MSSM}} + \lambda_{ijk} L_i L_j \overline{E}_k + \lambda'_{ijk} L_i Q_j \overline{D}_k + \kappa_i L_i H_u$

Advantages:

- Proton stable
- Automatic light neutrino masses
- Automatic dark matter candidate: axion or axino

Disadvantages:

- Not observed to date

Theory Motivation

- Krauss & Wilczek: Discrete symmetries violated by quantum gravity

- Unless remnant of spont. broken gauge symmetry

  $\Longrightarrow$ "discrete gauge symmetry"

- Ibanez & Ross: if original U(1) gauge symmetry is anomaly-free

  $\Longrightarrow$ conditions on the remnant discrete symmetry

  $\Longrightarrow$ "anomaly-free discrete gauge symmetry"

- HD,Luhn,Thormeier: syst. study of all $\mathbf{Z}_N$ with MSSM particle content

  $\Longrightarrow$ only 3 anomaly-free discrete gauge symmetries: P_6, R_p, B_3

Unification

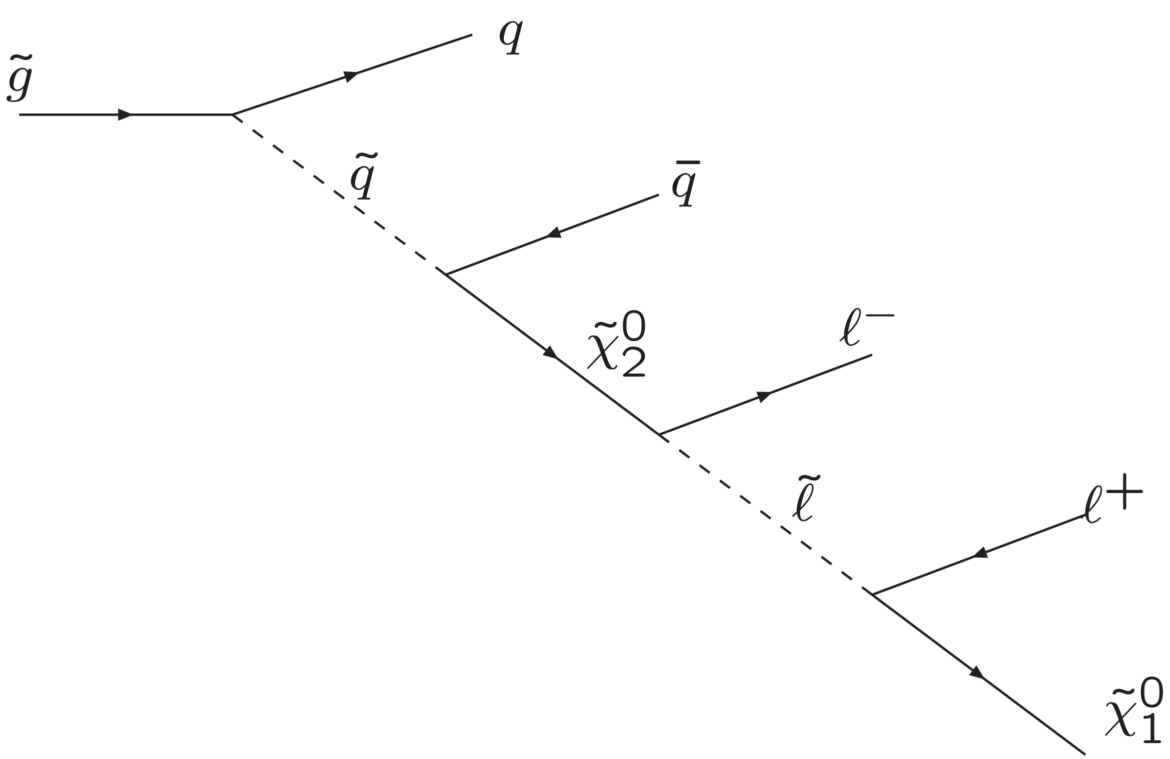
- P_6 and B_p not compatible with simple unbroken GUT gauge group
- R_p dangerous dim-5 proton decay operators

Summary

R-parity Violation   **equally well motivated**   R-Parity Conservation

R-Parity LHC Phenomenology

- SUSY Pair Production: $\tilde{g}\tilde{g}$, $\tilde{q}\tilde{q}$, $\tilde{g}\tilde{q}$
- Lightest SUSY Particle (LSP) stable: $\tilde{\chi}_1^0$
- Signature: jets + missing transverse energy (MET) + leptons



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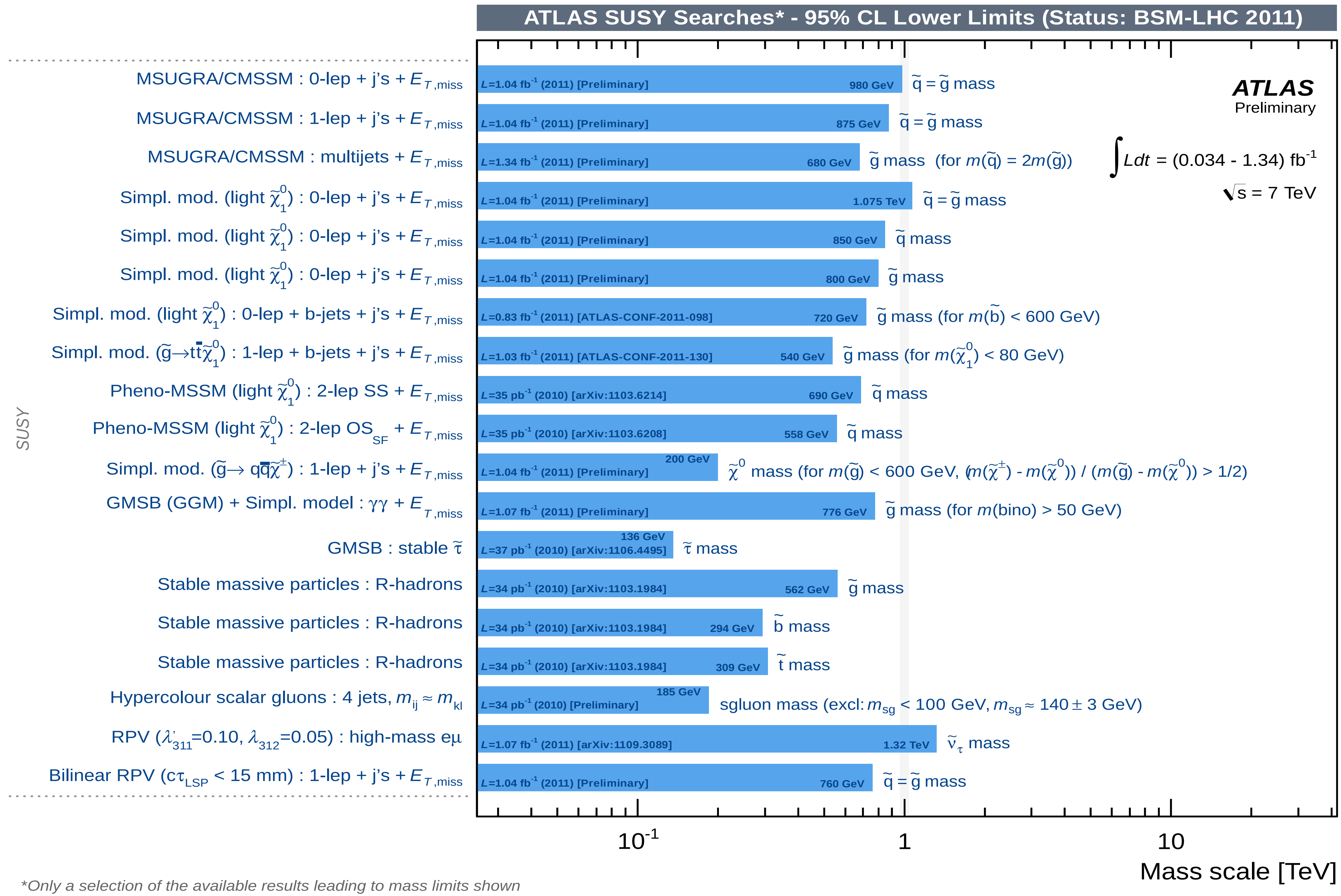
RPC SUSY Searches at the LHC

- **Signatures:** (ATLAS & CMS)
  - jets + MET
  - b-jets + MET
  - 1 lepton + jets + MET
  - 2 leptons + MET
  - 2 photons + MET
  - 1 lepton + 1 photon + MET
  - stable colored particle(s)



ATLAS SUSY Searches* - 95% CL Lower Limits (Status: BSM-LHC 2011)
ATLAS
Preliminary
∫Ldt = (0.034 - 1.34) fb^-1
√s = 7 TeV
SUSY
MSUGRA/CMSSM : 0-lep + j's + E_T,miss
L=1.04 fb^-1 (2011) [Preliminary]
980 GeV
q̃ = g̃ mass
MSUGRA/CMSSM : 1-lep + j's + E_T,miss
L=1.04 fb^-1 (2011) [Preliminary]
875 GeV
q̃ = g̃ mass
MSUGRA/CMSSM : multijets + E_T,miss
L=1.34 fb^-1 (2011) [Preliminary]
680 GeV
g̃ mass (for m(q̃) = 2m(g̃))
Simpl. mod. (light χ̃_1^0) : 0-lep + j's + E_T,miss
L=1.04 fb^-1 (2011) [Preliminary]
1.075 TeV
q̃ = g̃ mass
Simpl. mod. (light χ̃_1^0) : 0-lep + j's + E_T,miss
L=1.04 fb^-1 (2011) [Preliminary]
850 GeV
q̃ mass
Simpl. mod. (light χ̃_1^0) : 0-lep + j's + E_T,miss
L=1.04 fb^-1 (2011) [Preliminary]
800 GeV
g̃ mass
Simpl. mod. (light χ̃_1^0) : 0-lep + b-jets + j's + E_T,miss
L=0.83 fb^-1 (2011) [ATLAS-CONF-2011-098]
720 GeV
g̃ mass (for m(b̃) < 600 GeV)
Simpl. mod. (g̃→tt̄χ̃_1^0) : 1-lep + b-jets + j's + E_T,miss
L=1.03 fb^-1 (2011) [ATLAS-CONF-2011-130]
540 GeV
g̃ mass (for m(χ̃_1^0) < 80 GeV)
Pheno-MSSM (light χ̃_1^0) : 2-lep SS + E_T,miss
L=35 pb^-1 (2010) [arXiv:1103.6214]
690 GeV
q̃ mass
Pheno-MSSM (light χ̃_1^0) : 2-lep OS_SF + E_T,miss
L=35 pb^-1 (2010) [arXiv:1103.6208]
558 GeV
q̃ mass
Simpl. mod. (g̃→ qq̄χ̃^±) : 1-lep + j's + E_T,miss
L=1.04 fb^-1 (2011) [Preliminary]
200 GeV
χ̃^0 mass (for m(g̃) < 600 GeV, (m(χ̃^±) - m(χ̃^0)) / (m(g̃) - m(χ̃^0)) > 1/2)
GMSB (GGM) + Simpl. model : γγ + E_T,miss
L=1.07 fb^-1 (2011) [Preliminary]
776 GeV
g̃ mass (for m(bino) > 50 GeV)
GMSB : stable τ̃
L=37 pb^-1 (2010) [arXiv:1106.4495]
136 GeV
τ̃ mass
Stable massive particles : R-hadrons
L=34 pb^-1 (2010) [arXiv:1103.1984]
562 GeV
g̃ mass
Stable massive particles : R-hadrons
L=34 pb^-1 (2010) [arXiv:1103.1984]
294 GeV
b̃ mass
Stable massive particles : R-hadrons
L=34 pb^-1 (2010) [arXiv:1103.1984]
309 GeV
t̃ mass
Hypercolour scalar gluons : 4 jets, m_ij ≈ m_kl
L=34 pb^-1 (2010) [Preliminary]
185 GeV
sgluon mass (excl: m_sg < 100 GeV, m_sg ≈ 140 ± 3 GeV)
RPV (λ'_311=0.10, λ_312=0.05) : high-mass eμ
L=1.07 fb^-1 (2011) [arXiv:1109.3089]
1.32 TeV
ν̃_τ mass
Bilinear RPV (cτ_LSP < 15 mm) : 1-lep + j's + E_T,miss
L=1.04 fb^-1 (2011) [Preliminary]
760 GeV
q̃ = g̃ mass
10^-1
1
10
Mass scale [TeV]
*Only a selection of the available results leading to mass limits shown

B_3-Phenomenology: Lepton Number Violation

- charge current universality ($\pi \to e\nu$)

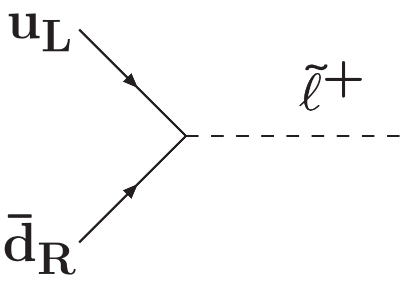
LOW-ENERGY BOUNDS ON λ, λ' (2σ):

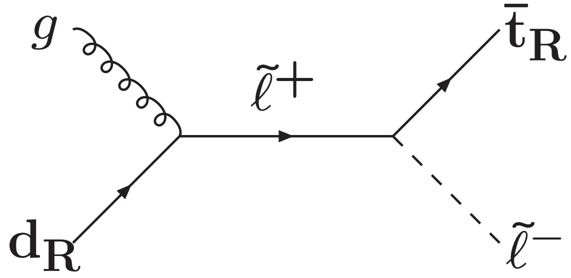
	$\lambda_{ijk} L_i L_j \bar{E}_k$	$\lambda'_{1jk} L_1 Q_j \bar{D}_k$	$\lambda'_{2jk} L_2 Q_j \bar{D}_k$	$\lambda'_{3jk} L_3 Q_j \bar{D}_k$
weakest	0.07	0.28	0.56	0.52
strongest	0.05	$5. \cdot 10^{-4}$	0.06	0.11

- One operator at a time
- (almost all) Bounds scale with ($\tilde{m}/100$) GeV
- Thus for 1 TeV sparticles bounds factor 10 weaker

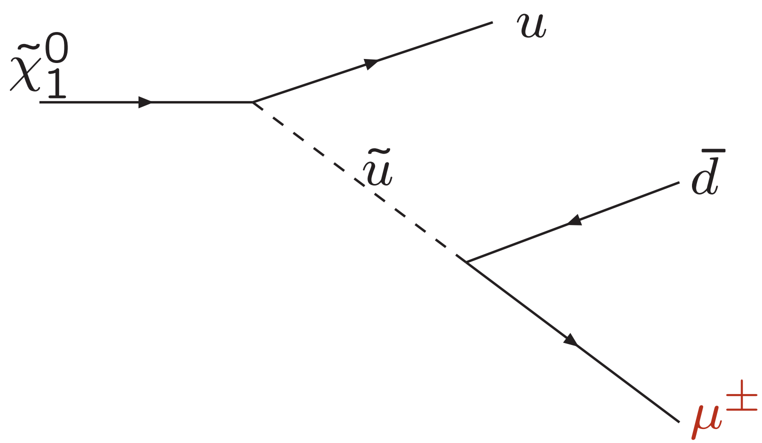
B_3-Phenomenology: Main Changes

1. Resonant/Associated Single SUSY Production possible





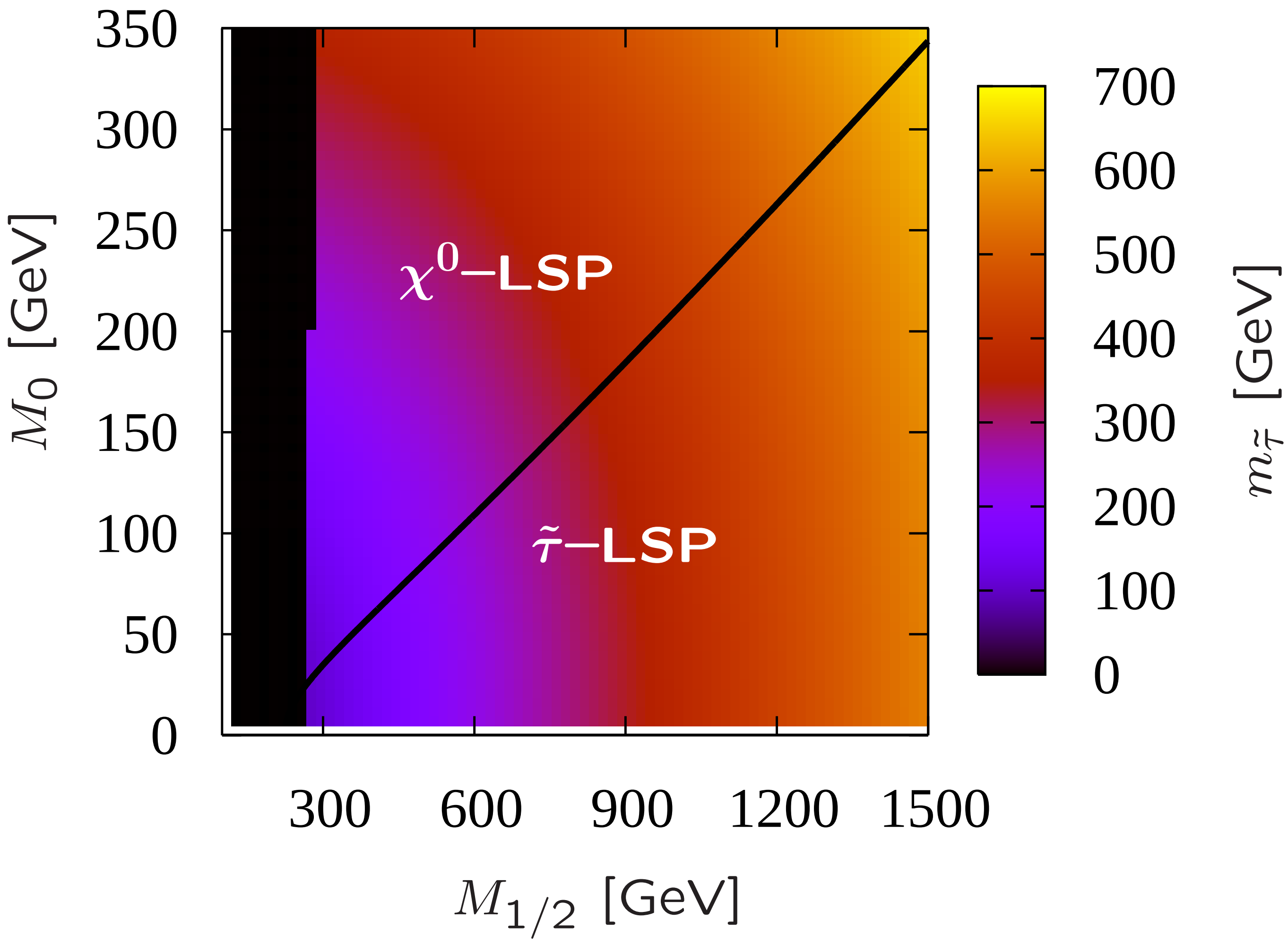
2. LSP is no longer stable



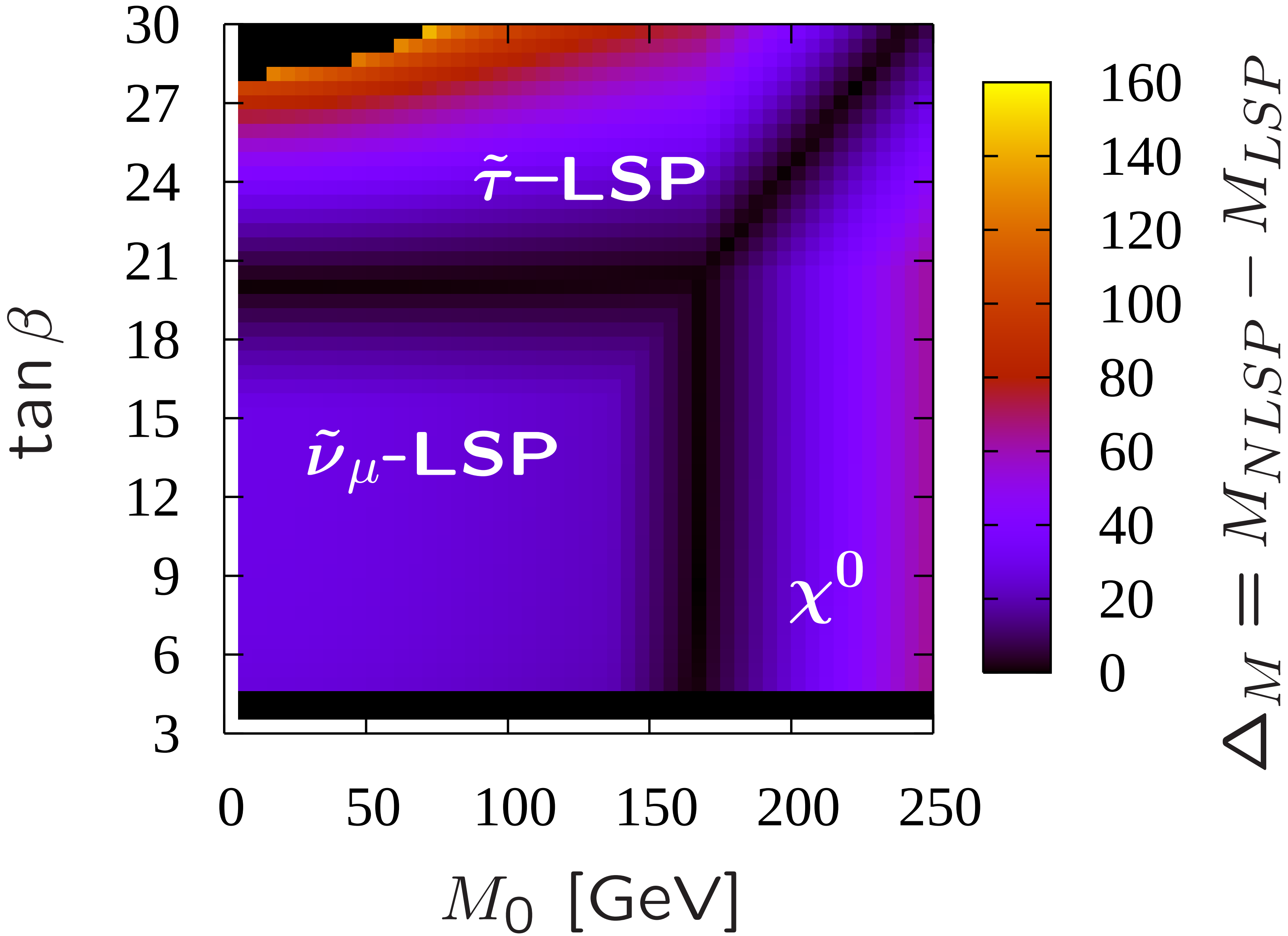
3. LSP $\in \{\chi_1^0, \chi_1^+, \tilde{\nu}_L, \tilde{\ell}^\pm_{L,R}, \tilde{\tau}_1^\pm, \tilde{q}_{L,R}, \tilde{g}\}$

4. In CMSSM/mSUGRA spectrum can differ

$\tilde{\tau}$-LSP with $\Lambda = 0$



- SPS1a($M_0 = 100$ GeV, $M_{1/2} = 250$ GeV) chosen so χ_1^0 is LSP



$M_{1/2} = 500$ GeV, $A = -500$ GeV, sgn(μ)=+1, $\lambda'_{221} = 0.1$

Plethora of new Signatures

$$\begin{pmatrix} \text{pair production}: \ \tilde{q}\tilde{q},\ \tilde{q}\tilde{g}\ \tilde{g}\tilde{g} \\ \text{resonant } \tilde{\ell} \text{ production} \end{pmatrix} \otimes \begin{pmatrix} \textbf{LSP} \\ \tilde{\chi}_1^0 \\ \tilde{\chi}_1^+ \\ \tilde{\nu}_L \\ \tilde{\ell}_{L,R}^{\pm} \\ \tilde{\tau}_1^{\pm} \\ \tilde{q}_{L,R} \\ \tilde{g} \end{pmatrix} \otimes \begin{pmatrix} L_1 L_2 \bar{E}_1 \\ \vdots \\ L_2 L_3 \bar{E}_3 \\ L_e Q_1 \bar{D}_1 \\ \vdots \\ L_\mu Q_1 \bar{D}_1 \\ \vdots \\ L_\tau Q_3 \bar{D}_3 \end{pmatrix}$$

- With one dominant operator something like 441 possibilities
- Where to start?
- mSUGRA/RGEs; possible LSPs: $(\tilde{\chi}_1^0, \tilde{\tau})$, $\quad(\tilde{\nu}, \tilde{\ell}_R)$

First Step: $\tilde{\chi}_1^0$–LSP

- Pair production: $\tilde{q}\tilde{q}$, $\tilde{q}\tilde{g}$, $\tilde{g}\tilde{g}$

- $\tilde{\chi}_1^0$–LSP: $\tilde{\chi}_1^0 \rightarrow \begin{cases} \ell^\pm + \ell^\mp + \not{p}_T & \mathsf{L_1L_{2,3}\bar{E}_{1,2},\ L_2L_3\bar{E}_1} \\ \ell^\pm + \tau^\mp + \not{p}_T & \mathsf{L_{1,2}L_3\bar{E}_3} \\ \ell^\pm + 2\,\text{jets} & \mathsf{L_{1,2}Q_i\bar{D}_k} \\ \ell^\pm + 2\,\text{jets} & \mathsf{L_{1,2}Q_i\bar{D}_k} \end{cases}$ $\qquad \ell = e, \mu$

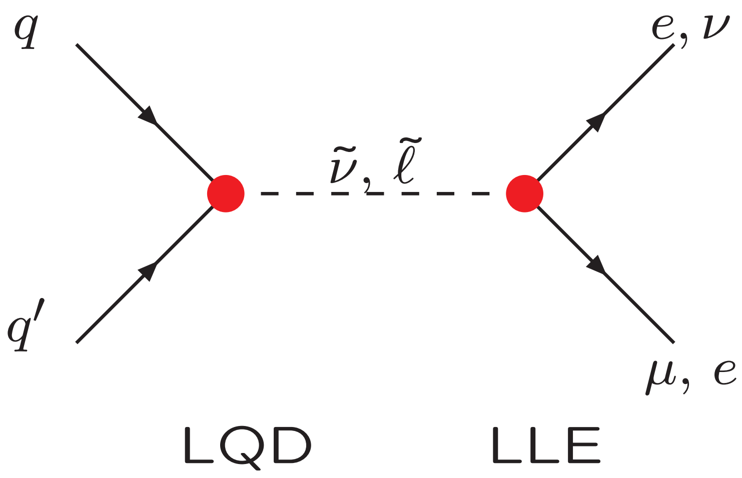
- Signatures: 4 charged leptons + $\not{p}_T$ + jets $\quad (e^+e^+\mu^-\mu^- + \text{jets})$

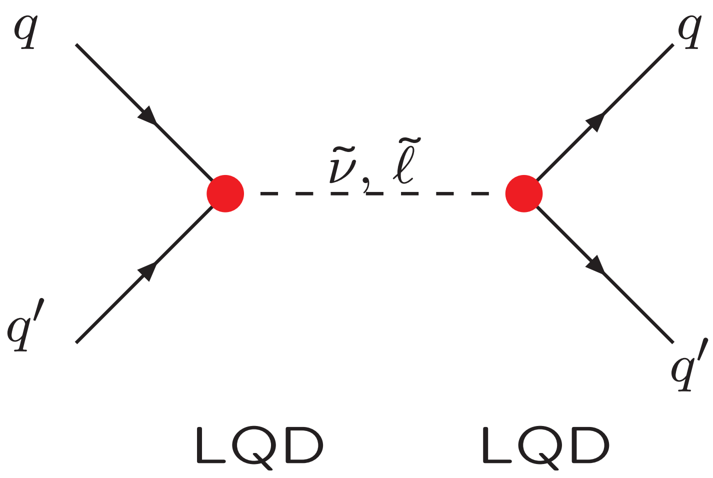
  $(e^+e^+\tau^-\tau^- + \text{jets})$

  like–sign dileptons + $\not{p}_T$ + jets $\quad (\ell^+\ell^+ + \text{jets})$

- For UDD must rely on (like sign di-) leptons from cascade or jet sub-structure à la Butterworth et al.

Resonant Production ($\tilde{\chi}_1^0$–LSP)





- Signatures: dilepton resonance: $(e^+e^-,\ \mu^+\mu^-,\ e^+\mu^-,\ e^+\tau^-,\ \mu^+\tau^-)$

  mono lepton: $(e^\pm\nu,\ \mu^\pm\nu,\ \tau^\pm\nu)$

  dijet resonance: (qq')

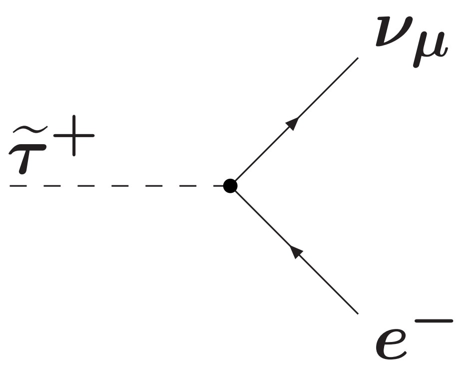
- For cascade slepton decay: $\tilde{\ell}^+ \to \ell^+ + \chi_1^0 \ \to \ell^+ + (\ell^+ + 2\,\text{jets})$

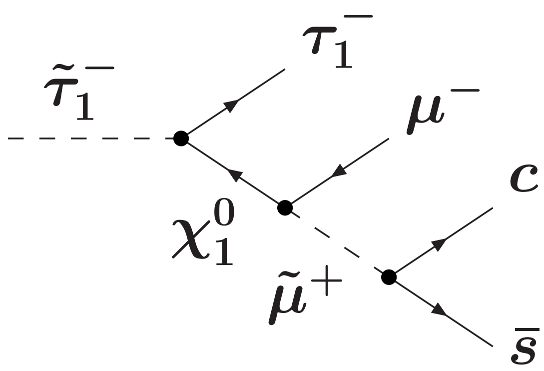
  like–sign dilepton: $(e^+e^+,\ \mu^+\mu^+,\ \tau^+\tau^+)$

Second Step: $\tilde{\tau}$–LSP

- Pair production: $\tilde{q}\tilde{q}$, $\tilde{q}\tilde{g}$, $\tilde{g}\tilde{g}$

- Cascade decay to $\tilde{\tau}$, (possibly) via χ_1^0 gives extra τ's in final state





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$L_i L_j \bar{E}_k$, $L_i Q_\ell \bar{D}_m$ (i, j, or $k = 3$) (i, j, AND $k \neq 3$)

$\tilde{\tau}$–LSP Signatures

- $\underline{L L \bar{E}}$: (a) $\tau \in L L \bar{E}$ $\quad \tau^+\tau^+ e^- e^- \nu\nu$

  (b) $\tau \notin L L \bar{E}$ $\quad \mu^+\mu^+ e^- e^- \nu\nu +$ 4τ's

.

- $\underline{L Q \bar{D}}$: (a) $\tau \in L Q \bar{D}$ $\quad \tau^+\tau^+ +$ 6 jets, no $\not{p}_T$

  (b) $\tau \notin L Q \bar{D}$ $\quad$ 4τ's $+ \not{p}_T +$ 4 jets

.

- So similar to χ_1^0–LSP but more τ's in final state
- Work in progress by Bonn ATLAS group (Desch, Fleischmann, Zimmermann ...)

Detached Vertices: Signatures

- LSP lifetime proportional to $(\lambda)^2$, $(\lambda')^2$
- χ_1^0–LSP decay prompt for λ, λ, $\gtrsim 10^{-5}$
- Asuming detached vertex for $c\tau > 1\,\mathrm{cm}$, have about 2 extra orders of magn. in λ, λ'
- For λ, $\lambda' \lesssim 10^{-7}$ regain conserved R_p at colliders (not cosmology!)
- New Signatures: long lived χ_1^0, $\tilde{\tau}$, or $(\tilde{q}/\tilde{g})$
- Decays: leptonic, semi-leptonic, or hadronic

Proposed Top 10 LHC RPV Signatures

	Signature	Model
1)	4 charged leptons: $e^+e^+\mu^-\mu^-$	χ_1^0–LSP, $LL\bar{E}$, $\tilde{\tau}$–LSP, $LL\bar{E}$
2)	2 leptons, 2 taus: $e^+e^+\tau^-\tau^-$	χ_1^0–LSP, $LL\bar{E}$, $\tilde{\tau}$–LSP, $LQ\bar{D}$
3)	like-sign dileptons + jets	χ_1^0–LSP, $LQ\bar{D}$
4)	dilepton resonance	$LL\bar{E} \otimes LQ\bar{D}$
5)	mono lepton	$LL\bar{E} \otimes LQ\bar{D}$
6)	dijet resonance	$LQ\bar{D}$, suppressed gaugino decays
7)	like sign ditau's $\tau^-\tau^-$ + 6jets	$\tilde{\tau}$–LSP, $LQ\bar{D}$
8)	late decaying χ_1^0–LSP	$\lambda \lesssim 10^{-5}$
9)	late decaying $\tilde{\tau}$–LSP	
10)	late decaying $\tilde{q}$ or $\tilde{g}$–LSP	

- Have not considered bilinear RPV models (W. Porod)

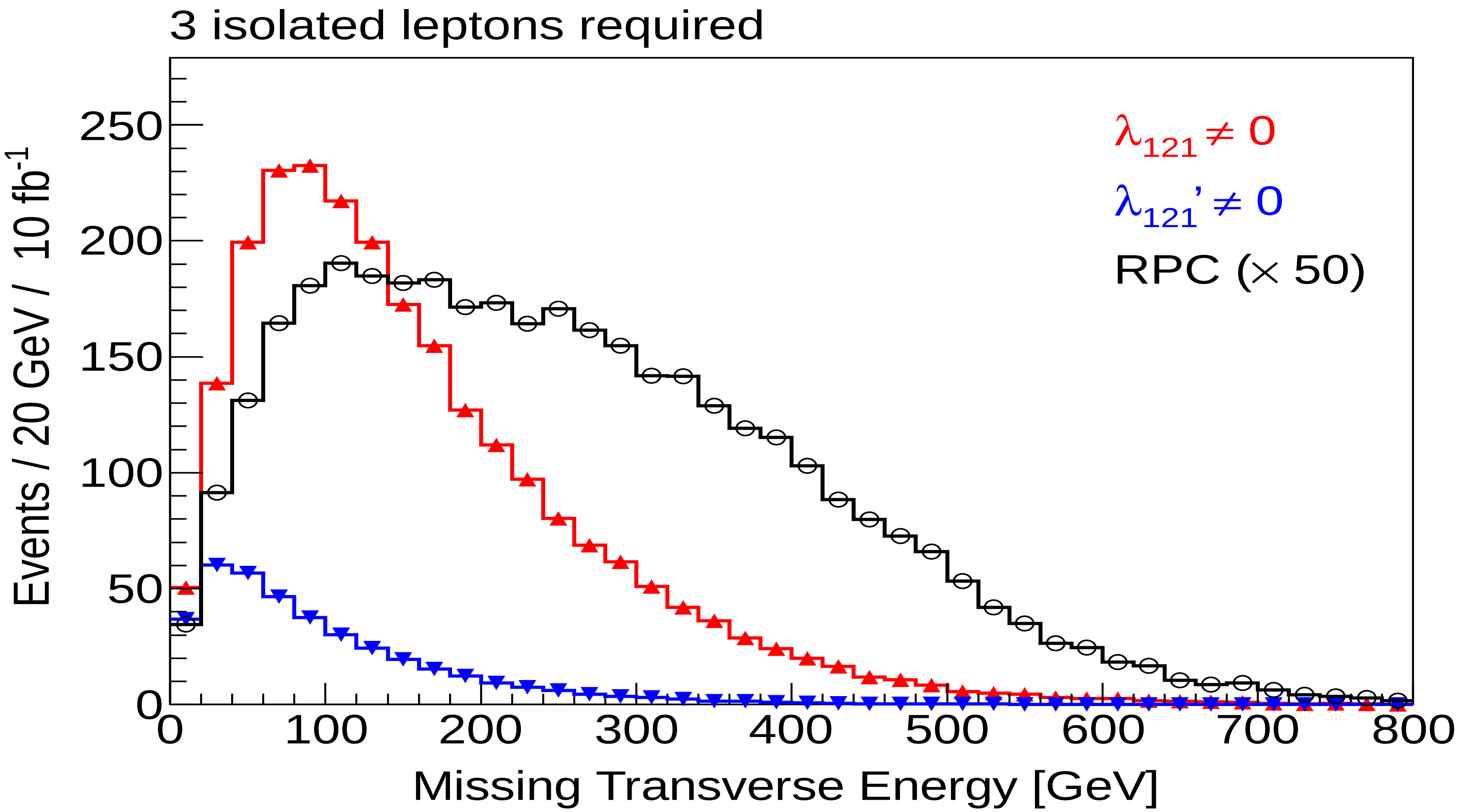
χ_1^0 LSP Decays in Detector

- Missing transverse energy diluted or absent
- Neutralino LSP decays:
  - $L L \bar{E}$: $\quad \tilde{\chi}_1^0 \rightarrow \begin{pmatrix} ee \\ e\mu \\ e\tau \\ \mu\mu \\ \mu\tau \end{pmatrix} + \nu$
  - $L Q \bar{D}$: $\quad \tilde{\chi}_1^0 \rightarrow \begin{pmatrix} e, \mu, \tau \\ \nu \end{pmatrix} + 2\,\text{jets}$
- Very few R-parity violating searches performed to–date
- Can maybe still use MET searches?

$M_0 = 150\,\text{GeV},\ M_{1/2} = 400\,\text{GeV},\ A_0 = 0,\ \tan\beta = 5,\ \text{sgn}(\mu) = +$

$\lambda_{121} = \lambda'_{121} = 0.001$

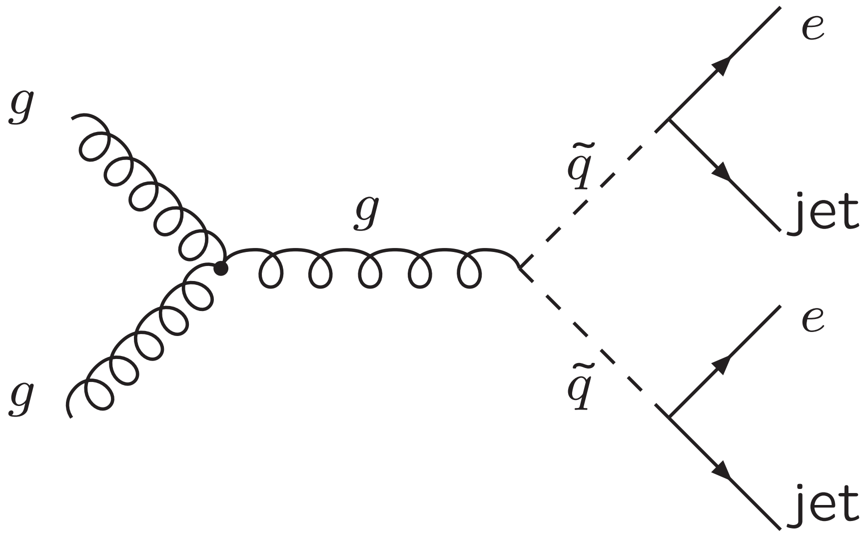
Tim Stefaniak



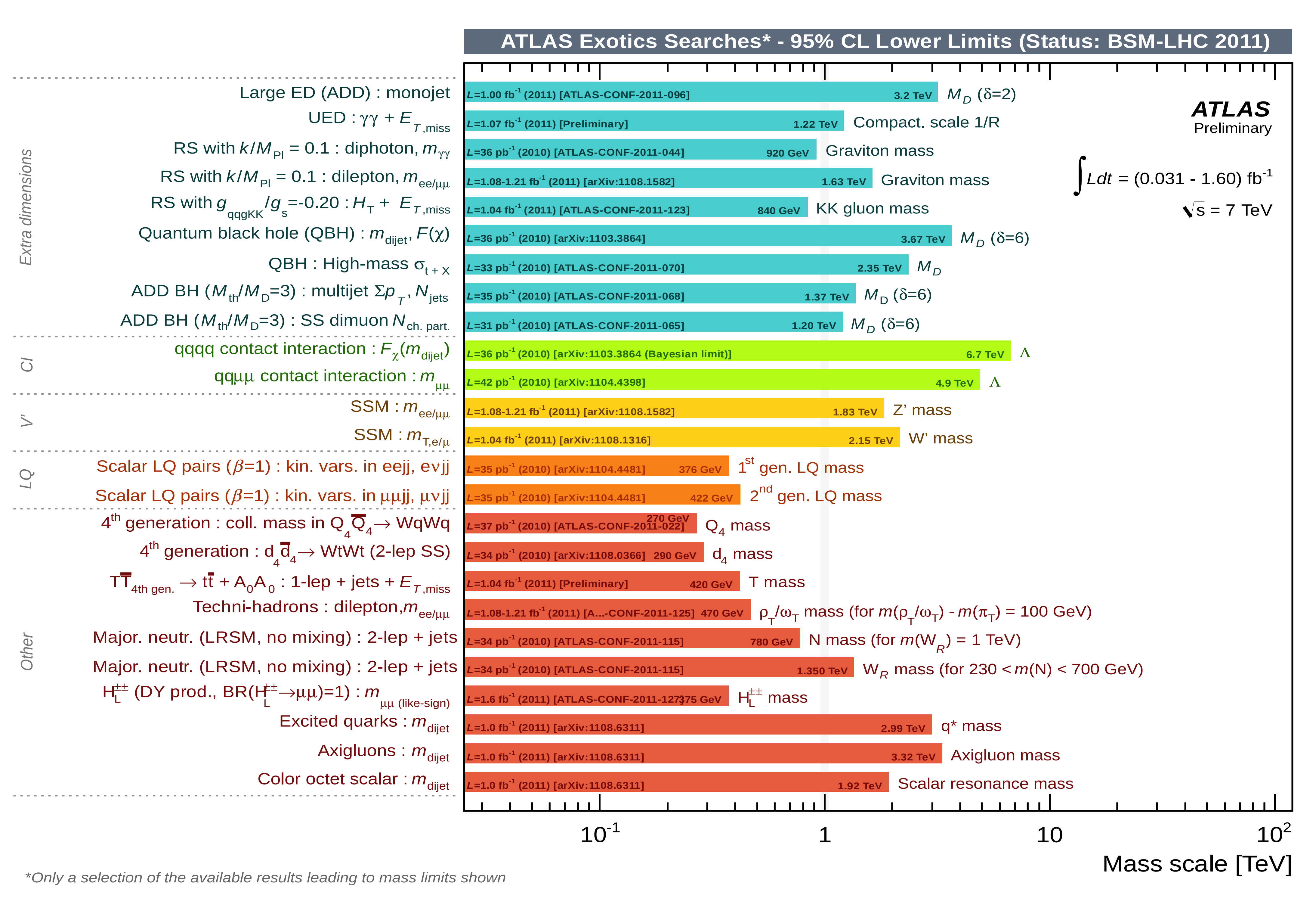
$M_{\tilde{\chi}_1^0} = 162\,,\ M_{\tilde{\tau}_1} = 214\,,\ M_{\tilde{t}_1} = 650\,,\ M_{\tilde{q}} = 865\,,\ M_{\tilde{g}} = 935\,\text{GeV}$

RPV and Leptoquarks

- Can also consider $\tilde{q}$–LSP
- Dominant $L_e Q_i \bar{D}_j$ operator



- Signature: $eejj$
- Can also have $\nu\nu jj$, or $\mu\mu jj$ $(L_\mu QD)$

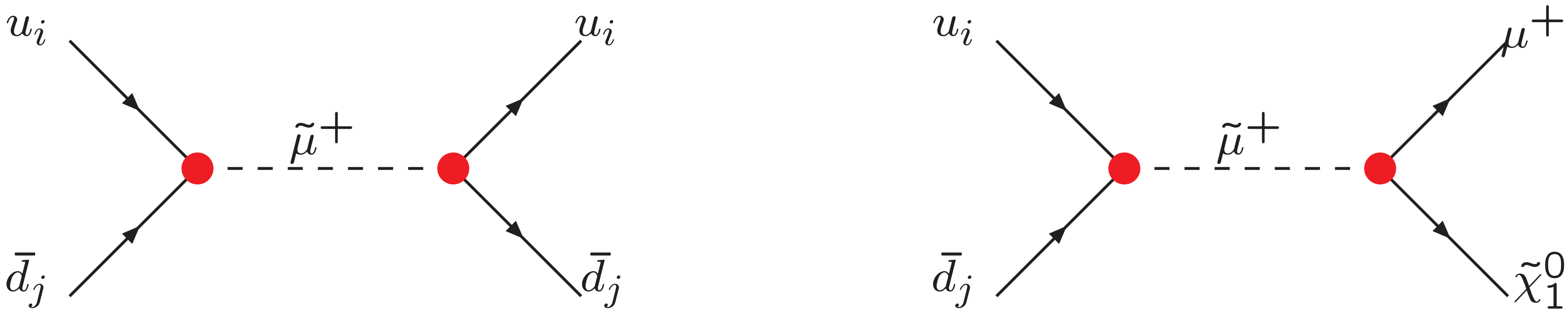


ATLAS Exotics Searches* - 95% CL Lower Limits (Status: BSM-LHC 2011)
ATLAS Preliminary
∫Ldt = (0.031 - 1.60) fb^-1
√s = 7 TeV
Extra dimensions
Large ED (ADD) : monojet — L=1.00 fb^-1 (2011) [ATLAS-CONF-2011-096] — 3.2 TeV — M_D (δ=2)
UED : γγ + E_T,miss — L=1.07 fb^-1 (2011) [Preliminary] — 1.22 TeV — Compact. scale 1/R
RS with k/M_Pl = 0.1 : diphoton, m_γγ — L=36 pb^-1 (2010) [ATLAS-CONF-2011-044] — 920 GeV — Graviton mass
RS with k/M_Pl = 0.1 : dilepton, m_ee/μμ — L=1.08-1.21 fb^-1 (2011) [arXiv:1108.1582] — 1.63 TeV — Graviton mass
RS with g_qqgKK/g_s=-0.20 : H_T + E_T,miss — L=1.04 fb^-1 (2011) [ATLAS-CONF-2011-123] — 840 GeV — KK gluon mass
Quantum black hole (QBH) : m_dijet, F(χ) — L=36 pb^-1 (2010) [arXiv:1103.3864] — 3.67 TeV — M_D (δ=6)
QBH : High-mass σ_t+X — L=33 pb^-1 (2010) [ATLAS-CONF-2011-070] — 2.35 TeV — M_D
ADD BH (M_th/M_D=3) : multijet Σp_T, N_jets — L=35 pb^-1 (2010) [ATLAS-CONF-2011-068] — 1.37 TeV — M_D (δ=6)
ADD BH (M_th/M_D=3) : SS dimuon N_ch. part. — L=31 pb^-1 (2010) [ATLAS-CONF-2011-065] — 1.20 TeV — M_D (δ=6)
CI
qqqq contact interaction : F_χ(m_dijet) — L=36 pb^-1 (2010) [arXiv:1103.3864 (Bayesian limit)] — 6.7 TeV — Λ
qqμμ contact interaction : m_μμ — L=42 pb^-1 (2010) [arXiv:1104.4398] — 4.9 TeV — Λ
V'
SSM : m_ee/μμ — L=1.08-1.21 fb^-1 (2011) [arXiv:1108.1582] — 1.83 TeV — Z' mass
SSM : m_T,e/μ — L=1.04 fb^-1 (2011) [arXiv:1108.1316] — 2.15 TeV — W' mass
LQ
Scalar LQ pairs (β=1) : kin. vars. in eejj, eνjj — L=35 pb^-1 (2010) [arXiv:1104.4481] — 376 GeV — 1st gen. LQ mass
Scalar LQ pairs (β=1) : kin. vars. in μμjj, μνjj — L=35 pb^-1 (2010) [arXiv:1104.4481] — 422 GeV — 2nd gen. LQ mass
Other
4th generation : coll. mass in Q_4 Q̄_4 → WqWq — L=37 pb^-1 (2010) [ATLAS-CONF-2011-022] — 270 GeV — Q_4 mass
4th generation : d_4 d̄_4 → WtWt (2-lep SS) — L=34 pb^-1 (2010) [arXiv:1108.0366] — 290 GeV — d_4 mass
TT̄_4th gen. → tt̄ + A_0A_0 : 1-lep + jets + E_T,miss — L=1.04 fb^-1 (2011) [Preliminary] — 420 GeV — T mass
Techni-hadrons : dilepton, m_ee/μμ — L=1.08-1.21 fb^-1 (2011) [A...-CONF-2011-125] — 470 GeV — ρ_T/ω_T mass (for m(ρ_T/ω_T) - m(π_T) = 100 GeV)
Major. neutr. (LRSM, no mixing) : 2-lep + jets — L=34 pb^-1 (2010) [ATLAS-CONF-2011-115] — 780 GeV — N mass (for m(W_R) = 1 TeV)
Major. neutr. (LRSM, no mixing) : 2-lep + jets — L=34 pb^-1 (2010) [ATLAS-CONF-2011-115] — 1.350 TeV — W_R mass (for 230 < m(N) < 700 GeV)
H_L^±± (DY prod., BR(H_L^±±→μμ)=1) : m_μμ (like-sign) — L=1.6 fb^-1 (2011) [ATLAS-CONF-2011-127] — 375 GeV — H_L^±± mass
Excited quarks : m_dijet — L=1.0 fb^-1 (2011) [arXiv:1108.6311] — 2.99 TeV — q* mass
Axigluons : m_dijet — L=1.0 fb^-1 (2011) [arXiv:1108.6311] — 3.32 TeV — Axigluon mass
Color octet scalar : m_dijet — L=1.0 fb^-1 (2011) [arXiv:1108.6311] — 1.92 TeV — Scalar resonance mass
10^-1
1
10
10^2
Mass scale [TeV]
*Only a selection of the available results leading to mass limits shown

Use existing searches: Resonant $\tilde{\ell}$, $\tilde{\nu}$ Prod.

with Tim Stefaniak

- One dominant operator: $L_2 Q_i \bar{D}_j$

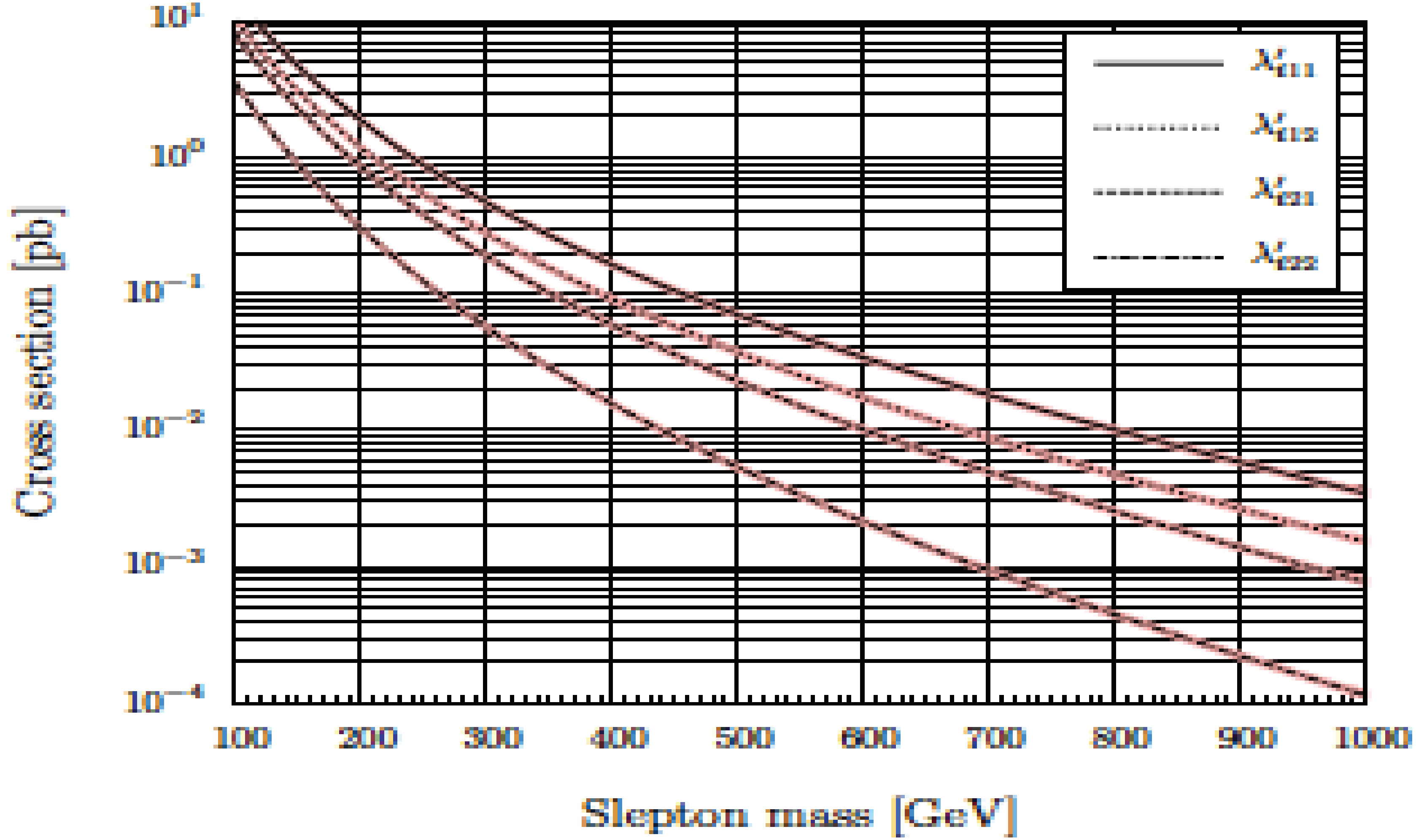


$\tilde{\chi}_1^0 \to \mu^+ + 2\,\text{jets}$

- Dijet resonance: compare with **ATLAS** and **CMS** searches ($1\,\text{fb}^{-1}$)

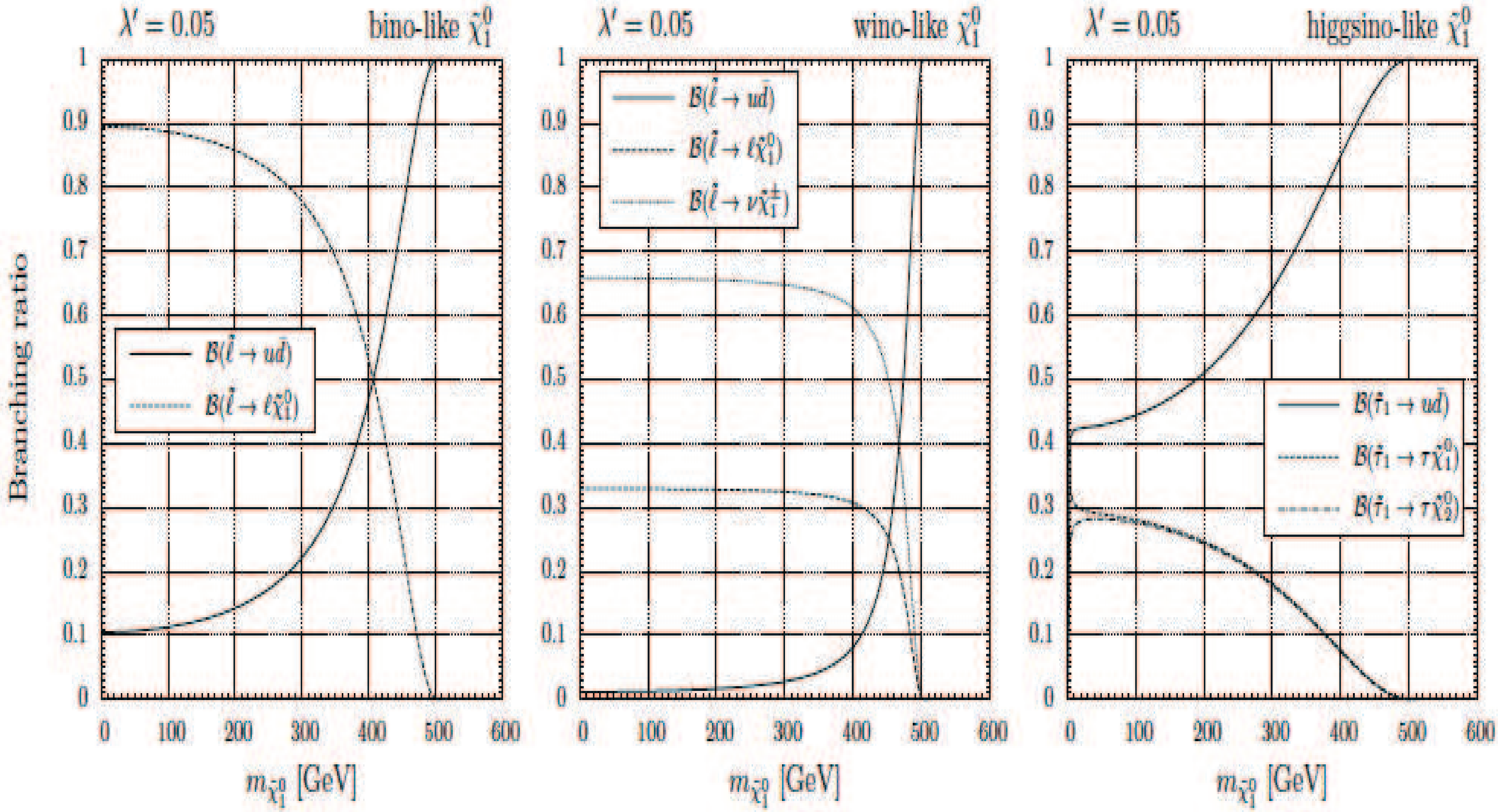
- Prompt like-sign μ's, compare with **ATLAS** search

Resonant Slepton Production Xsection

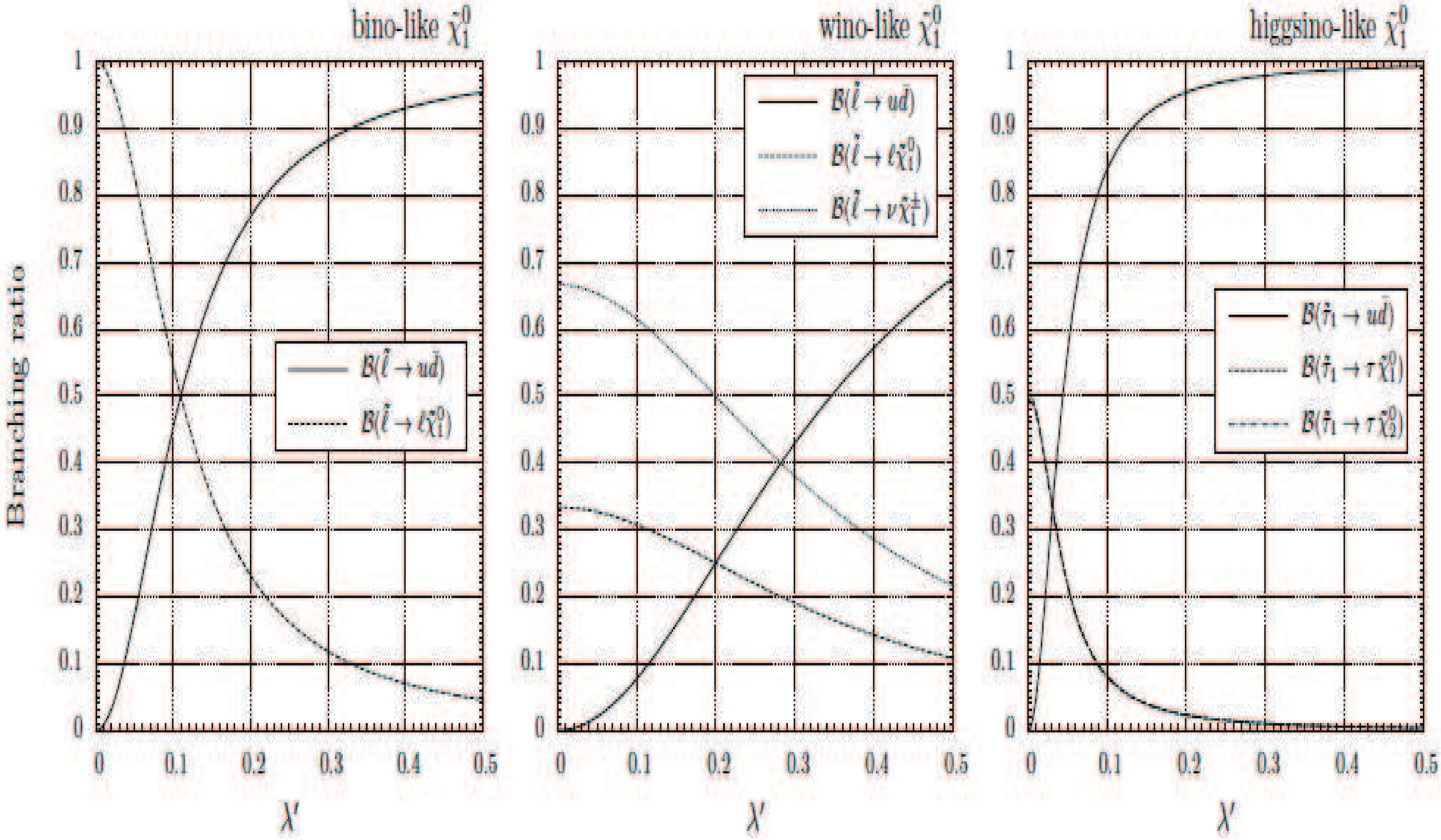


- $\lambda' = 0.01$

- CTEQ6m PDFs



$\lambda' = 0.05$
bino-like $\tilde{\chi}_1^0$
$\mathcal{B}(\tilde{\ell} \to u\bar{d})$
$\mathcal{B}(\tilde{\ell} \to \ell\tilde{\chi}_1^0)$
$\lambda' = 0.05$
wino-like $\tilde{\chi}_1^0$
$\mathcal{B}(\tilde{\ell} \to u\bar{d})$
$\mathcal{B}(\tilde{\ell} \to \ell\tilde{\chi}_1^0)$
$\mathcal{B}(\tilde{\ell} \to \nu\tilde{\chi}_1^\pm)$
$\lambda' = 0.05$
higgsino-like $\tilde{\chi}_1^0$
$\mathcal{B}(\tilde{\tau}_1 \to u\bar{d})$
$\mathcal{B}(\tilde{\tau}_1 \to \tau\tilde{\chi}_1^0)$
$\mathcal{B}(\tilde{\tau}_1 \to \tau\tilde{\chi}_2^0)$
Branching ratio
$m_{\tilde{\chi}_1^0}$ [GeV]

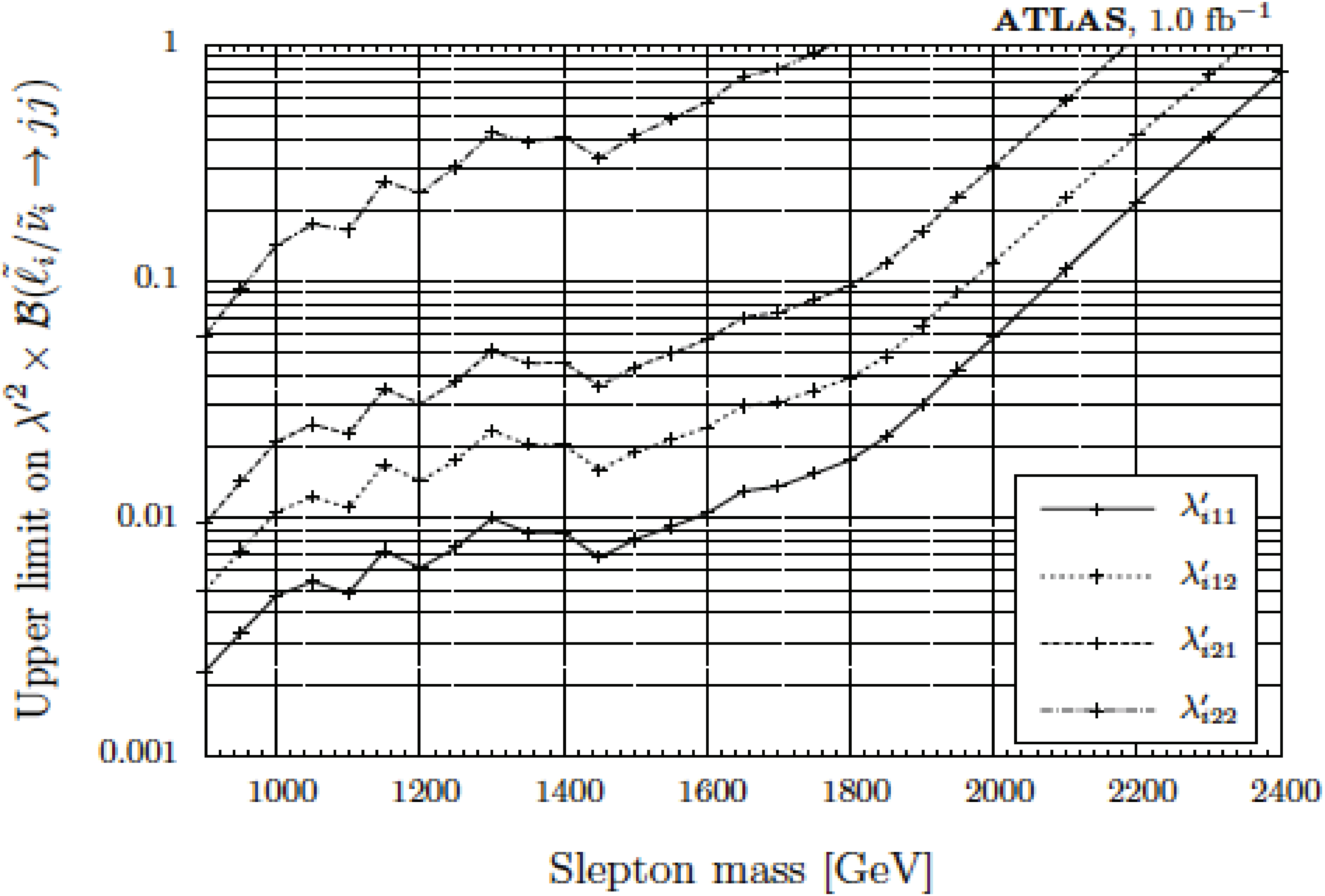


bino-like $\tilde{\chi}_1^0$
wino-like $\tilde{\chi}_1^0$
higgsino-like $\tilde{\chi}_1^0$
Branching ratio
λ'
λ'
λ'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
$\mathcal{B}(\tilde{\ell} \to u\bar{d})$
$\mathcal{B}(\tilde{\ell} \to \ell\tilde{\chi}_1^0)$
$\mathcal{B}(\tilde{\ell} \to \nu\tilde{\chi}_1^\pm)$
$\mathcal{B}(\tilde{\tau}_1 \to u\bar{d})$
$\mathcal{B}(\tilde{\tau}_1 \to \tau\tilde{\chi}_1^0)$
$\mathcal{B}(\tilde{\tau}_1 \to \tau\tilde{\chi}_2^0)$

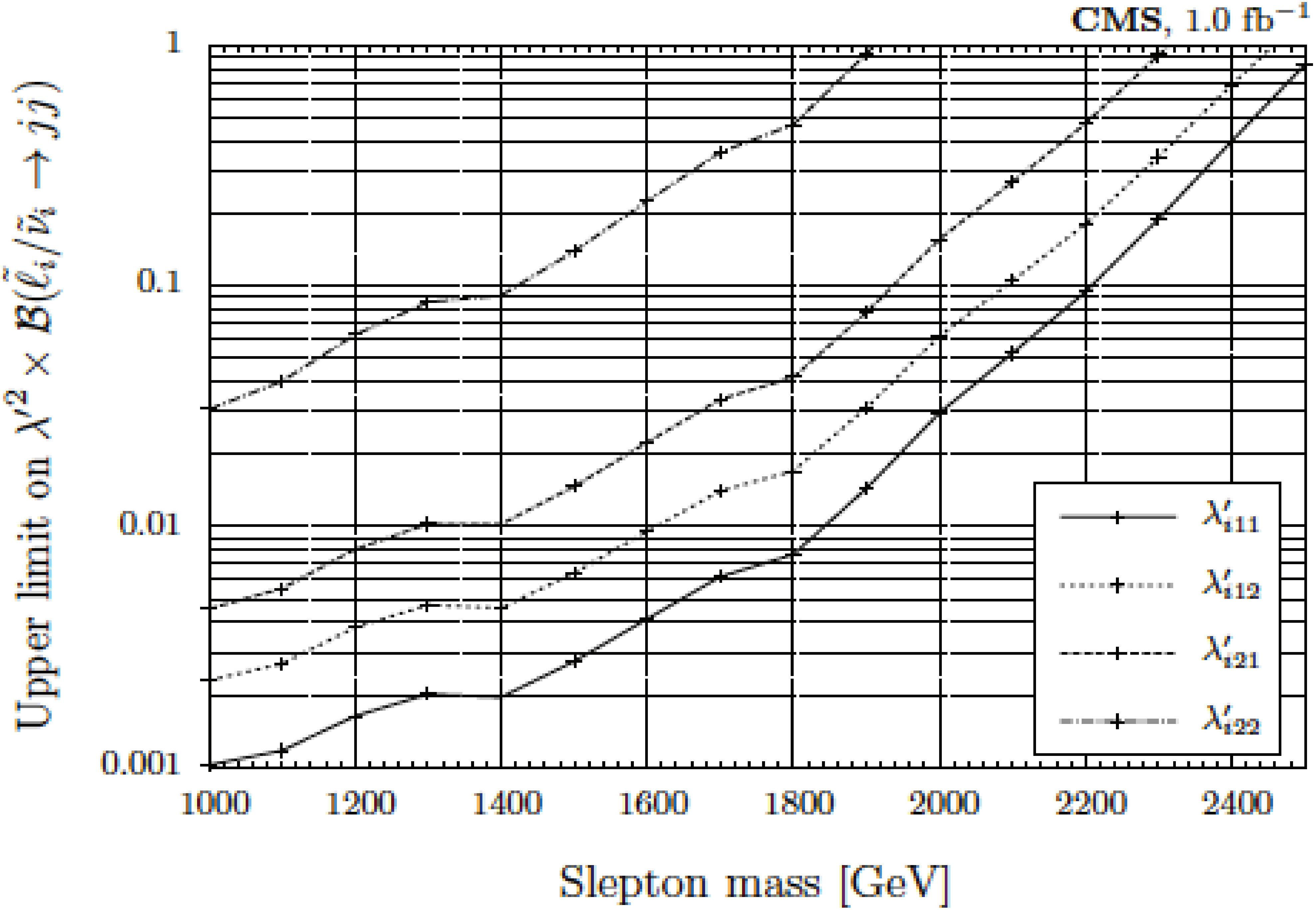
Resonant Dijet Search

- Mass range search ATLAS (CMS) 0.9 TeV (1 TeV)- 4.0 TeV (4.1 TeV)

- Simulated 25,000 signal events for each slepton mass



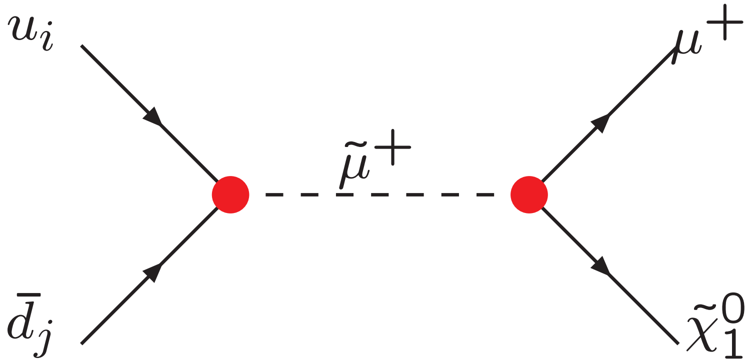
ATLAS, 1.0 fb^{-1}
Upper limit on $\lambda'^2 \times \mathcal{B}(\tilde{\ell}_i/\tilde{\nu}_i \to jj)$
1
0.1
0.01
0.001
1000
1200
1400
1600
1800
2000
2200
2400
Slepton mass [GeV]
λ'_{i11}
λ'_{i12}
λ'_{i21}
λ'_{i22}



CMS, 1.0 fb^{-1}
Upper limit on $\lambda'^2 \times \mathcal{B}(\tilde{\ell}_i/\tilde{\nu}_i \to jj)$
Slepton mass [GeV]
1
0.1
0.01
0.001
1000
1200
1400
1600
1800
2000
2200
2400
λ'_{i11}
λ'_{i12}
λ'_{i21}
λ'_{i22}

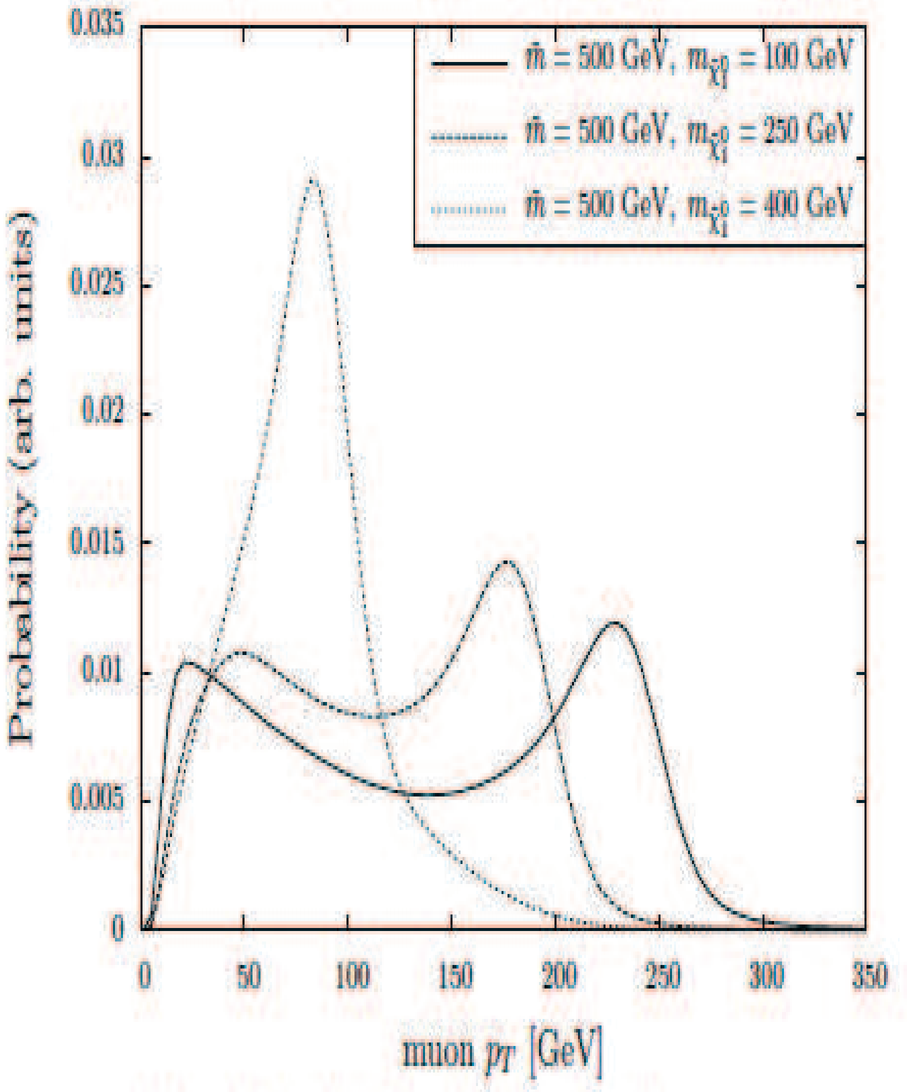
Like Sign Dileptons from Resonant Slepton Prod.

.

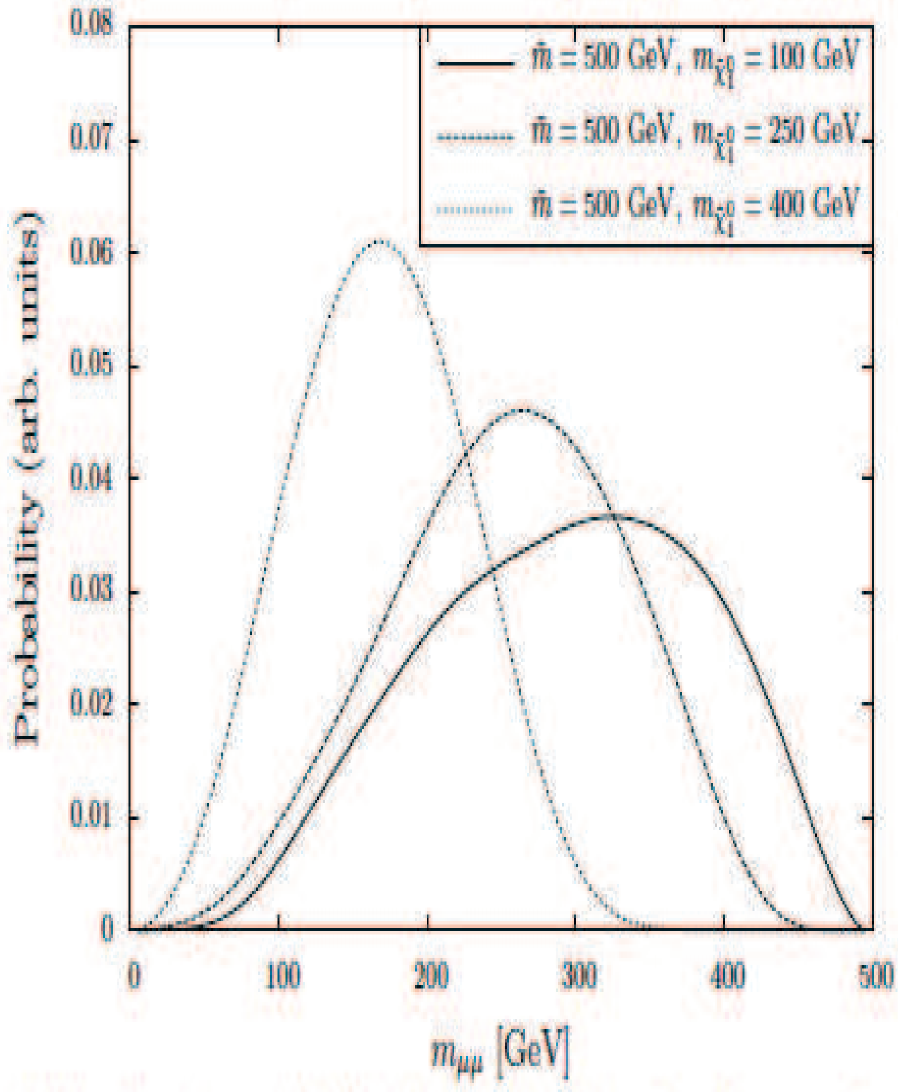


$\tilde{\chi}_1^0 \to \mu^+ + 2\,\text{jets}$

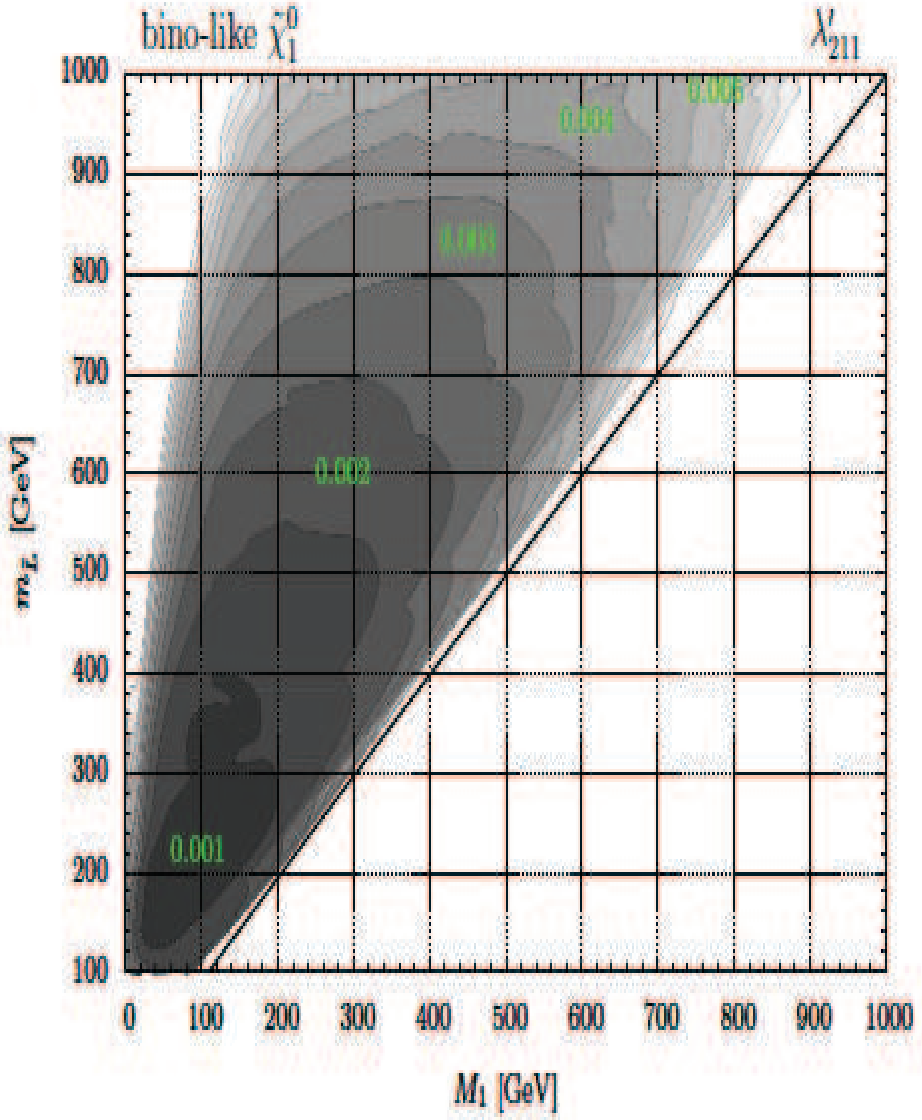
- Prompt like-sign μ's, compare with ATLAS search



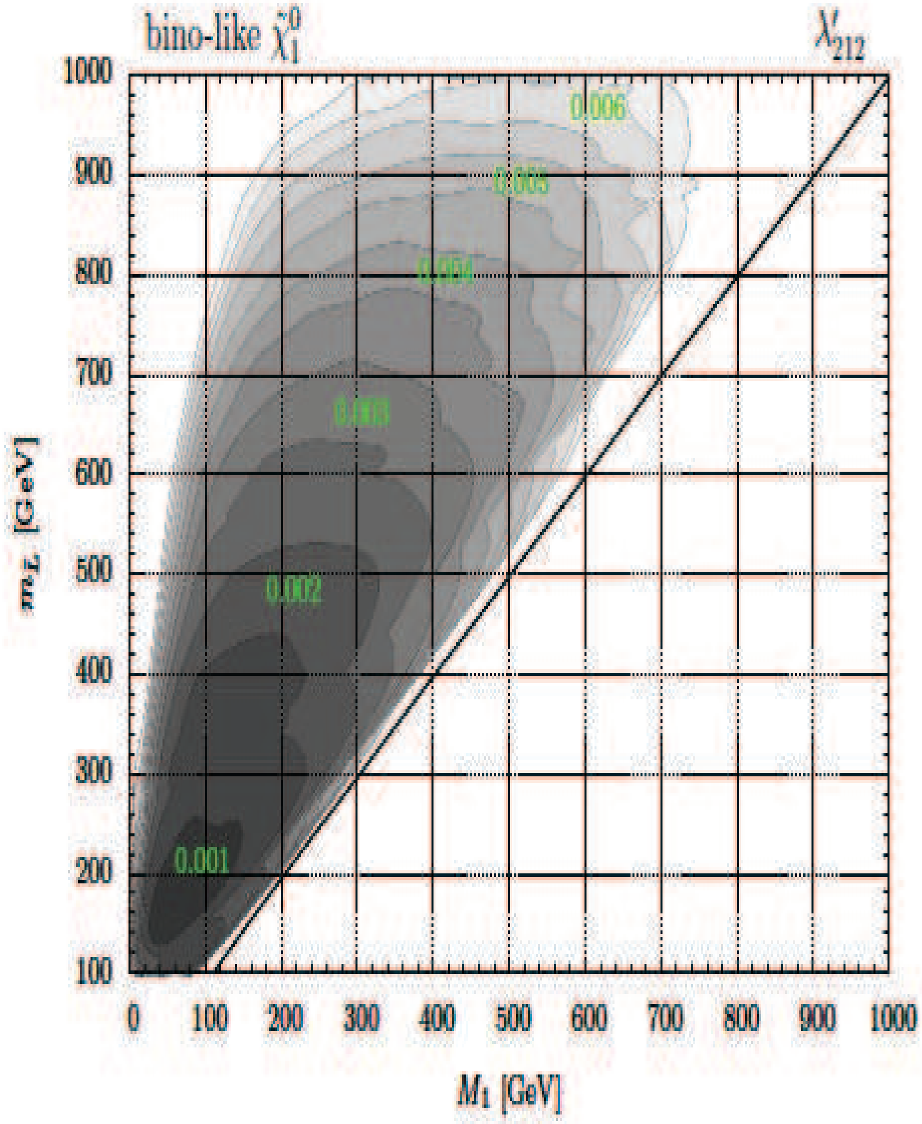
(a)p_T distrubution of the isolated muons.



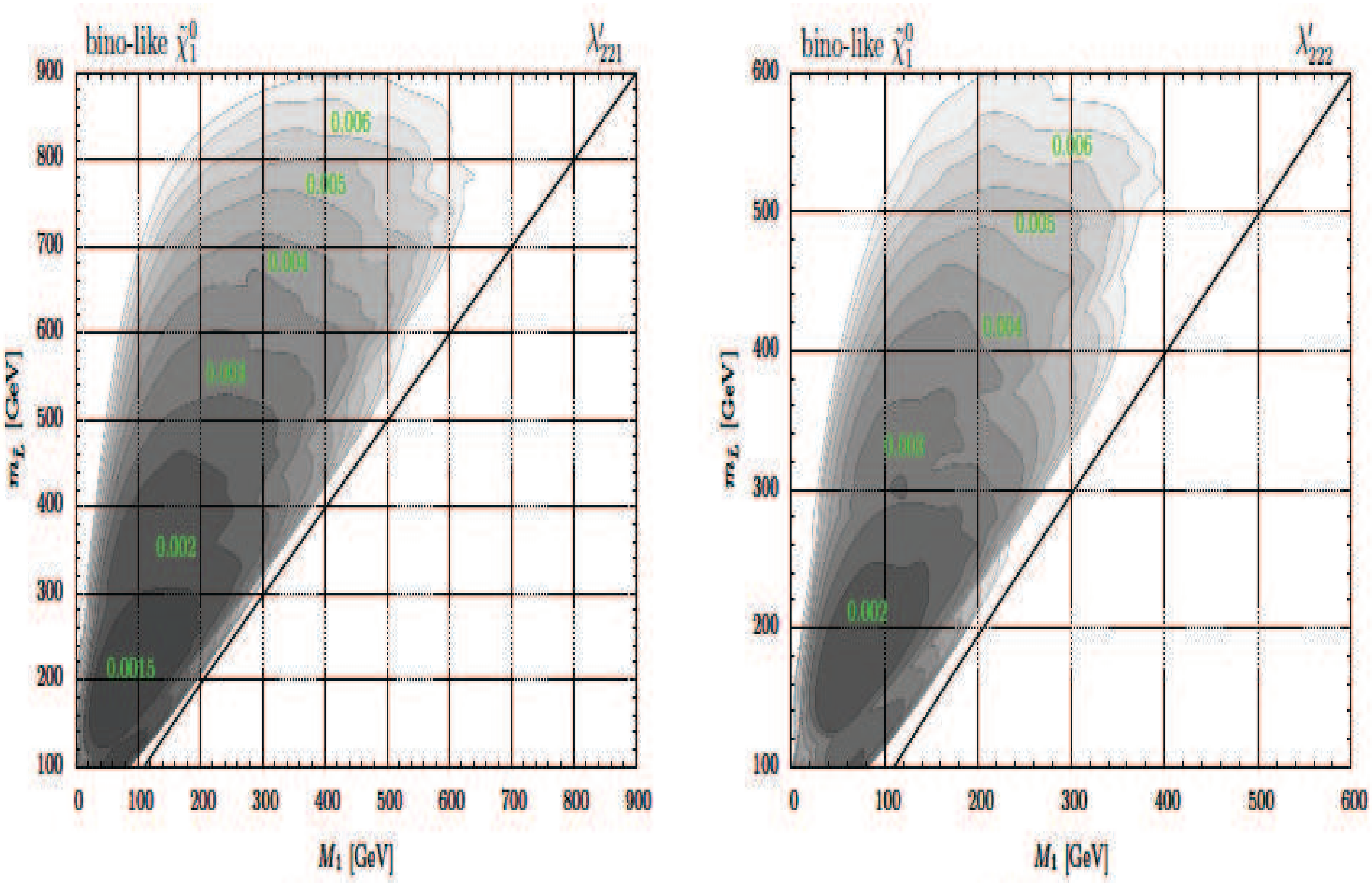
(b)Invariant mass distribution of the like–sign dimuon pairs.



(a)λ'_{211}.



(b)λ'_{212}.



(c)λ'_{221}.

(d)λ'_{222}.

Conclusions & Outlook

- Tried to argue that RPC and RPV equally well motivated
- Experimental effort almost exclusively on RPC so far
- Shown some simple well motivated signatures: multileptons, like-sign dileptons, dijet resonance bumps
- Compared resonant slepton production directly to existing ATLAS and CMS searches
- Outline of a top 10 list of signatures

Physikshow trip to Berlin: Weltmaschine Exhib.