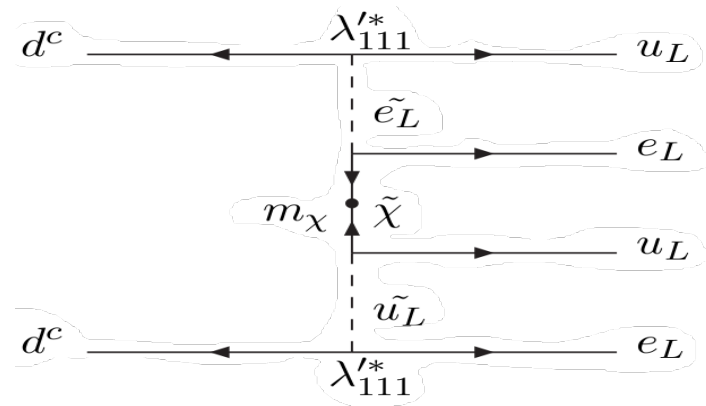
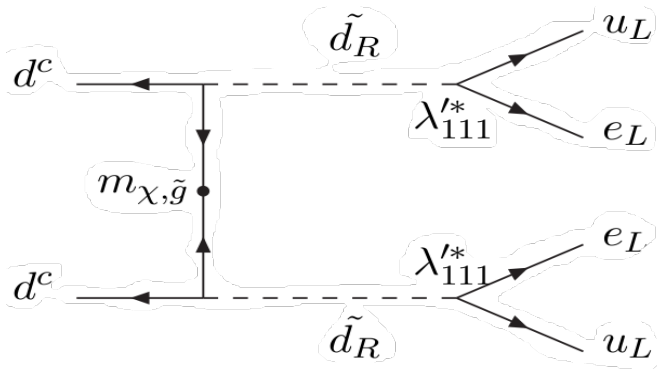
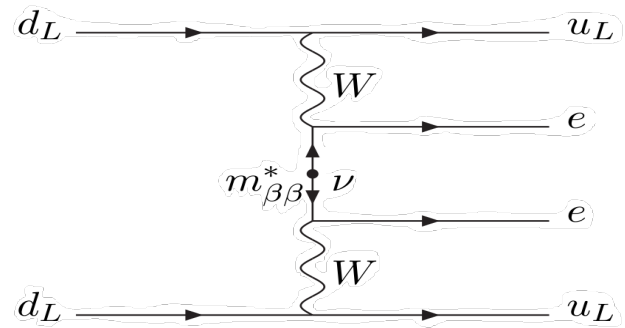


Discovery potential for like sign di-electrons as a test for neutrinoless double beta decay in RPV mSUGRA at the early LHC stage

Terascale Workshop 2010, Dresden
12/03/10

Introduction

- Neutrinoless Double Beta Decay ($0\nu 2\beta$)
 - Majorana Neutrino
 - Left-Right Symmetries
 - Supersymmetry



Introduction

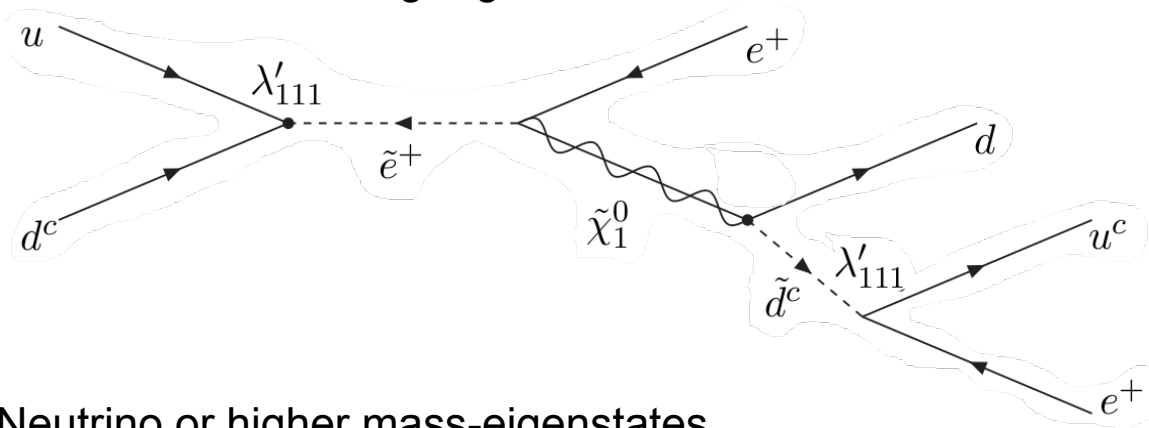
- Experimental Bound (Heidelberg-Moscow) within mSUGRA

$$|\lambda'_{111}| < 3.3 \times 10^{-4} \tilde{q}^2 \tilde{g}^{\frac{1}{2}}$$

- B. C. Allanach, C. H. Kom, H. Päs (2009): arXiv:0902.4697v1 [hep-ph], arXiv:0903.0347v3 [hep-ph]
→ Resonant Single Slepton Production via λ'_{111}
- mSUGRA with Neutralino-LSP; $A_0 = 0$, $\tan \beta = 10$, $\text{sign } \mu = -1$
- M_0 and $M_{\frac{1}{2}}$ remaining parameters

Signal + Background

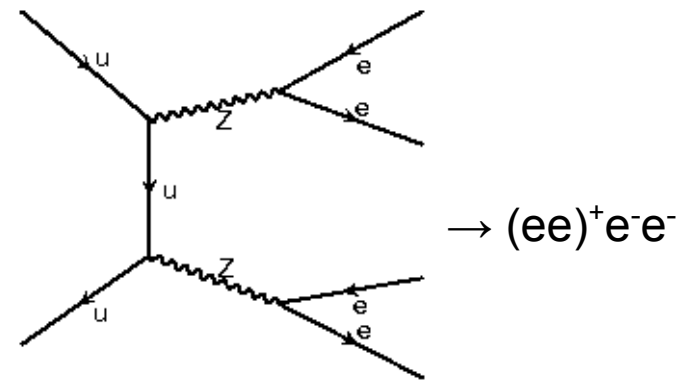
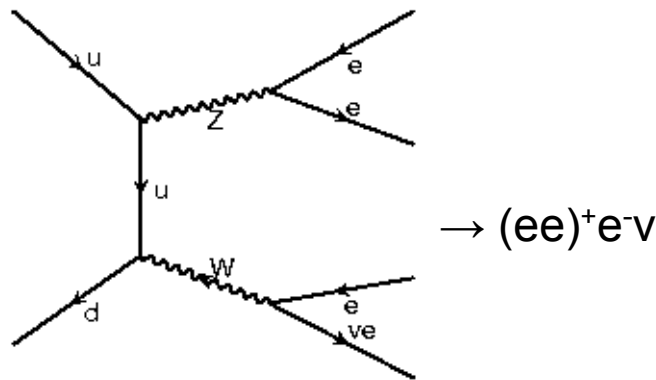
- Focus on mSUGRA processes sensitive to $(\lambda')^4$
 → Lepton Number Violating Signals



- Chargino/Neutrino or higher mass-eigenstates
- H. Dreiner, P. Richardson, M. Seymour (2001) [hep-ph/0007228v1]:
 - Like sign di-muon @ Tevatron and LHC
 - Main Background: Standard Model WZ/ZZ production
 - Other BG: QCD, Single Top, SUSY

Cut motivation

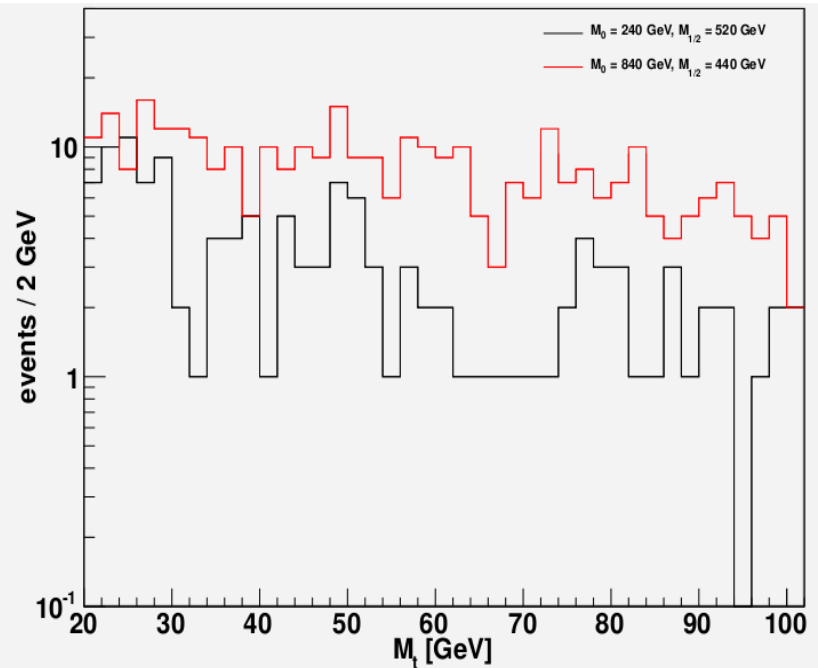
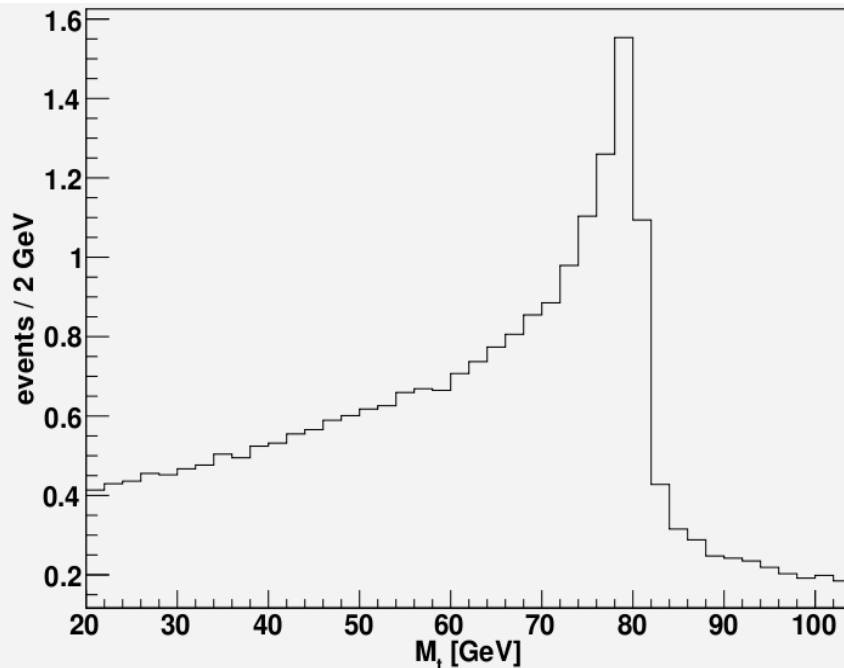
- Geometric cut: $|\eta| < 2.5$
- Neglected Background due to cuts
 - QCD, single top: lepton isolation + transverse momentum (p_t)
 - SUSY: number of jets + p_t of jets
- SM WZ/ZZ production



→ Veto on presence of „wrong-charged lepton“

Cut motivation

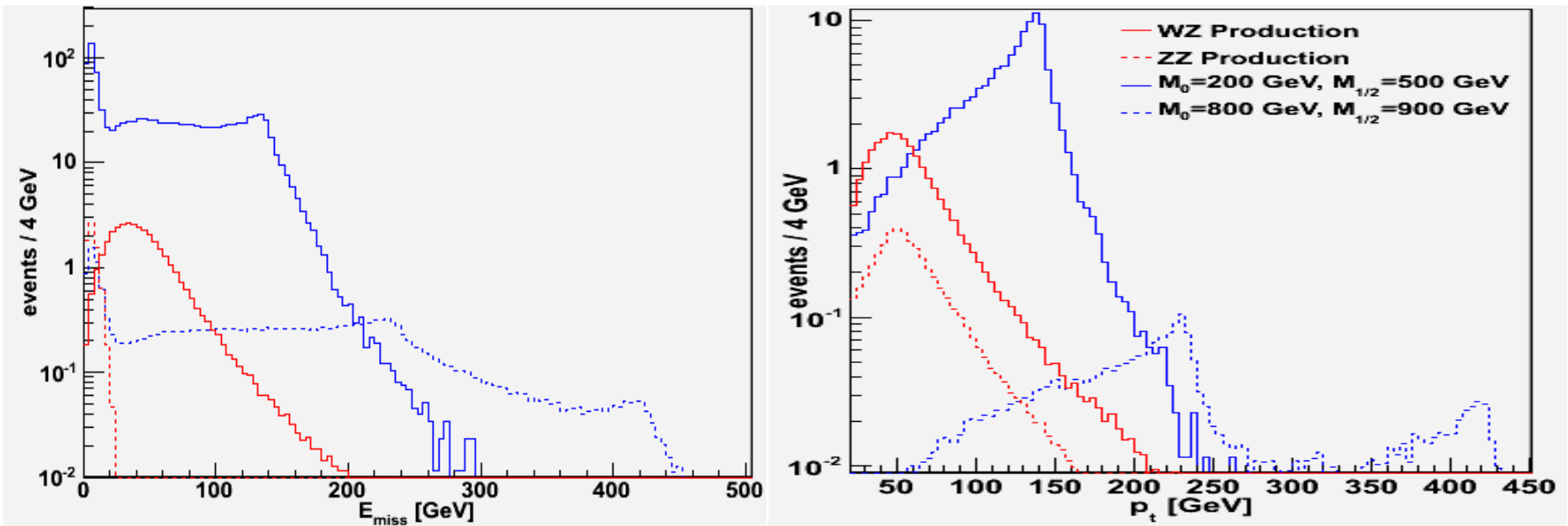
- Transverse Mass $M_T^2 = 2|p_{T_\ell}||p_{T_\nu}|(1 - \cos \Delta\phi_{\ell\nu})$



→ exclude $60 \text{ GeV} < M_T < 85 \text{ GeV}$

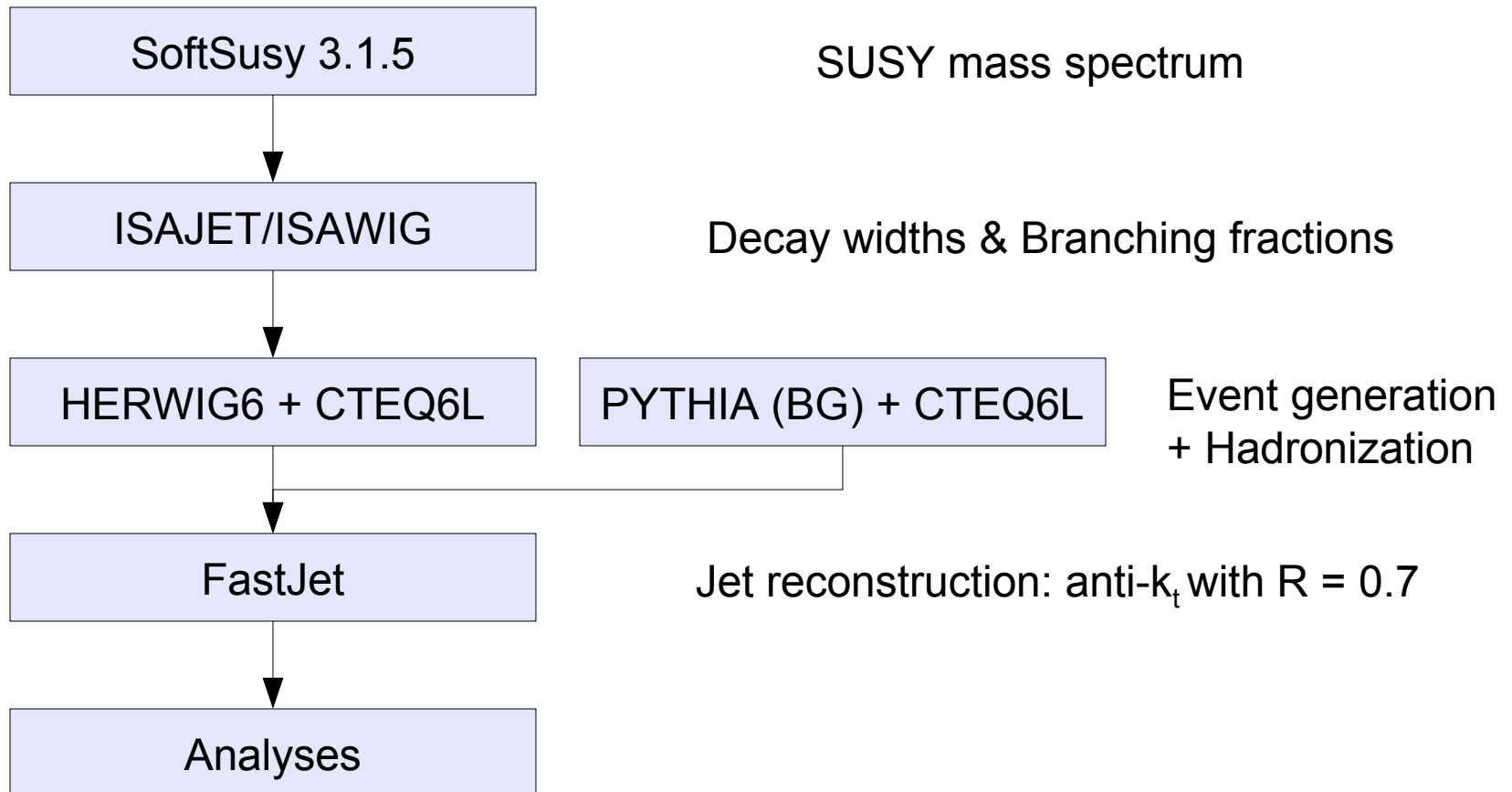
Cut motivation

- Important parameters: p_t (1st / 2nd hardest lepton) $[p_{t1}, p_{t2}]$, E_T^{miss}



- improve cuts at some points
- scan: $p_{t1}, p_{t2}, E_T^{\text{miss}}$ in 10 - 150 GeV

Framework



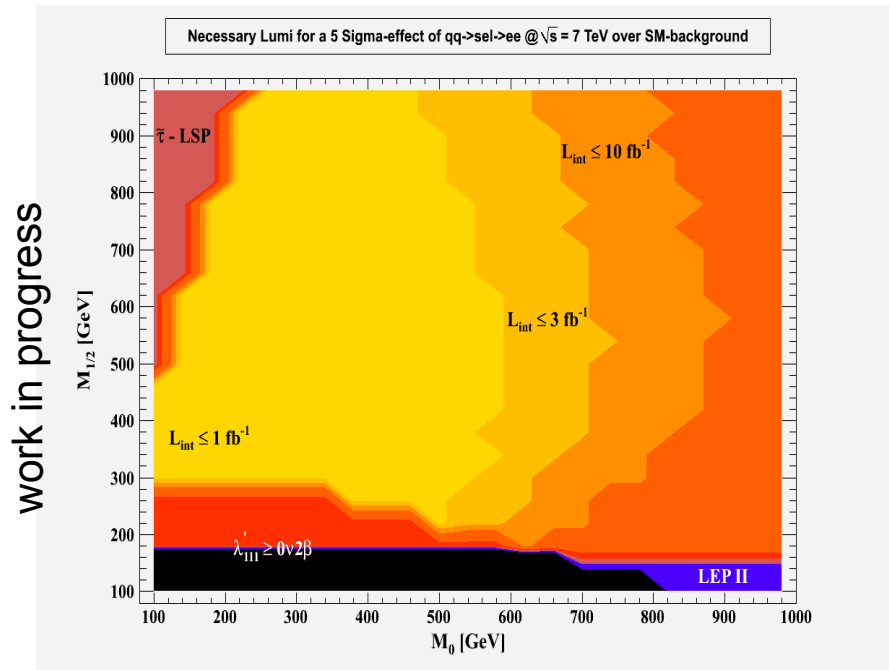
Cut improvement & Discovery Potential

- Test discovery potential with 14 TeV di-muon cuts
 - $p_{t1} > 40 \text{ GeV}$, $p_{t2} > 40 \text{ GeV}$, $E_T^{\text{miss}} < 20 \text{ GeV}$
- Choose points for cut-improvement
- Scan the p_{t1} - p_{t2} - E_T^{miss} parameter space with a 1331 point grid and 200k events for signal, WZ and ZZ each (M,p and E in GeV)

λ'_{111}	M_0	$M_{1/2}$	S	p_{t1}	p_{t2}	E_T^{miss}	S'
0.01	520	760	5.08	94	24	24	6.22
0.01	560	360	4.91	150	10	122	10.01
0.005	320	680	4.77	136	10	24	7.06
0.005	440	280	4.96	136	10	108	7.26

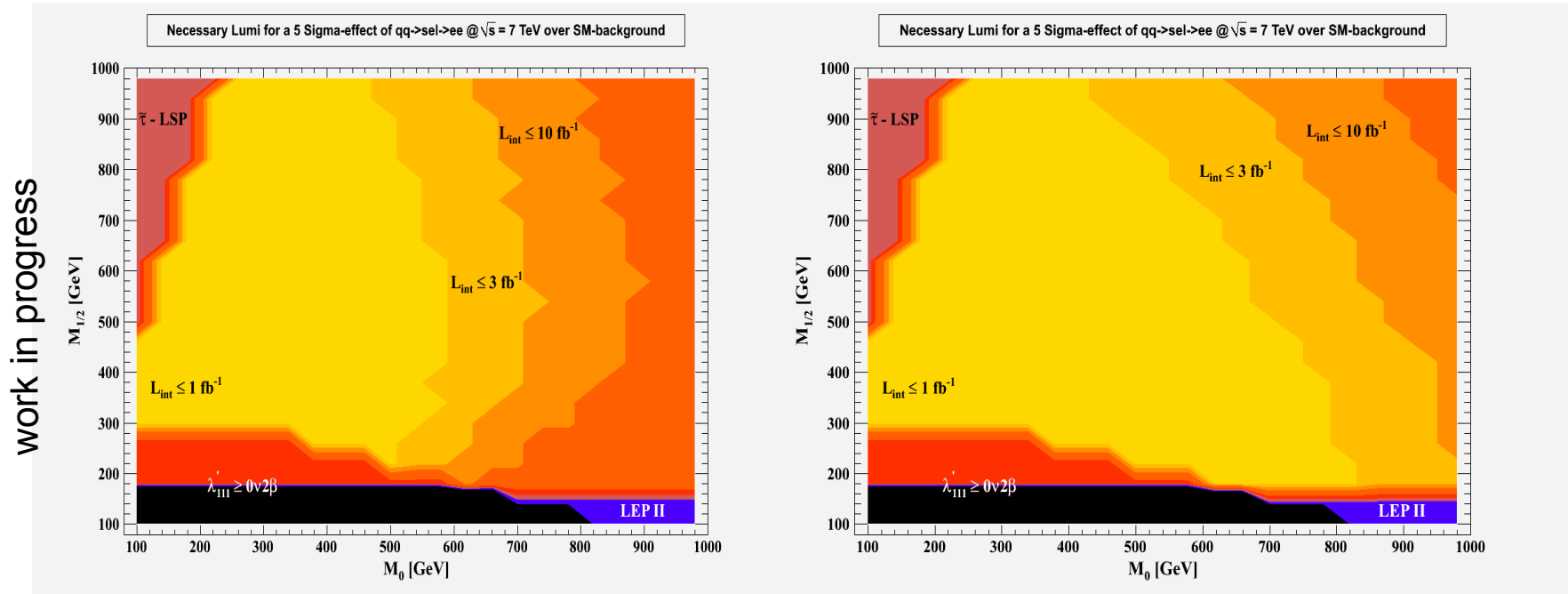
Cut improvement & Discovery Potential

- $M_0 - M_{1/2}$ scan on a 576 point grid
 - $\lambda'_{111} = 0.01$ at the GUT-scale; M_0 in 80 - 1000 GeV; $M_{1/2}$ in 80 - 1000 GeV



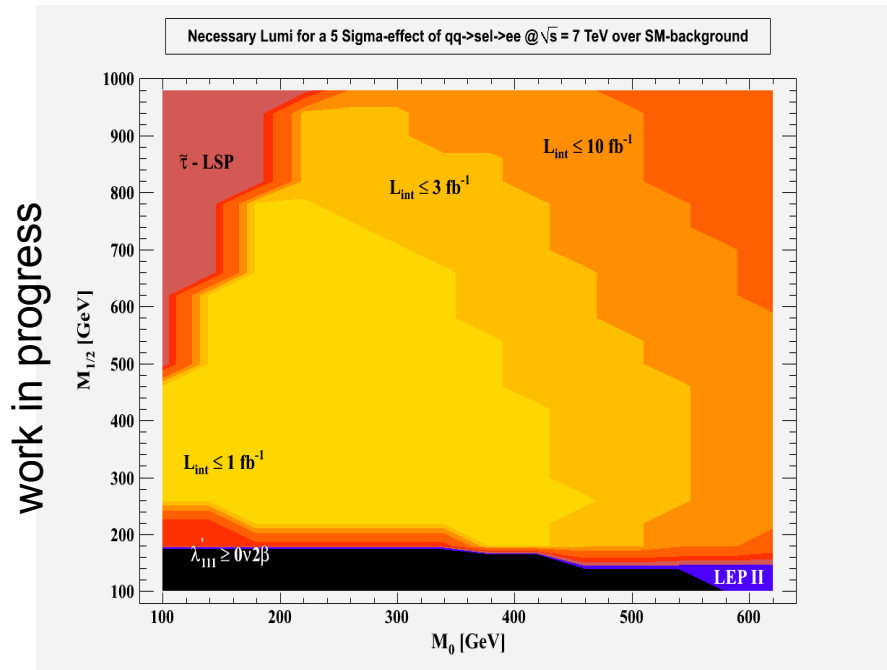
Cut improvement & Discovery Potential

- $M_0 - M_{1/2}$ scan with improved cuts on a 576 point grid
 - $\lambda'_{111} = 0.01$ at the GUT-scale; M_0 in 80 - 1000 GeV; $M_{1/2}$ in 80 - 1000 GeV



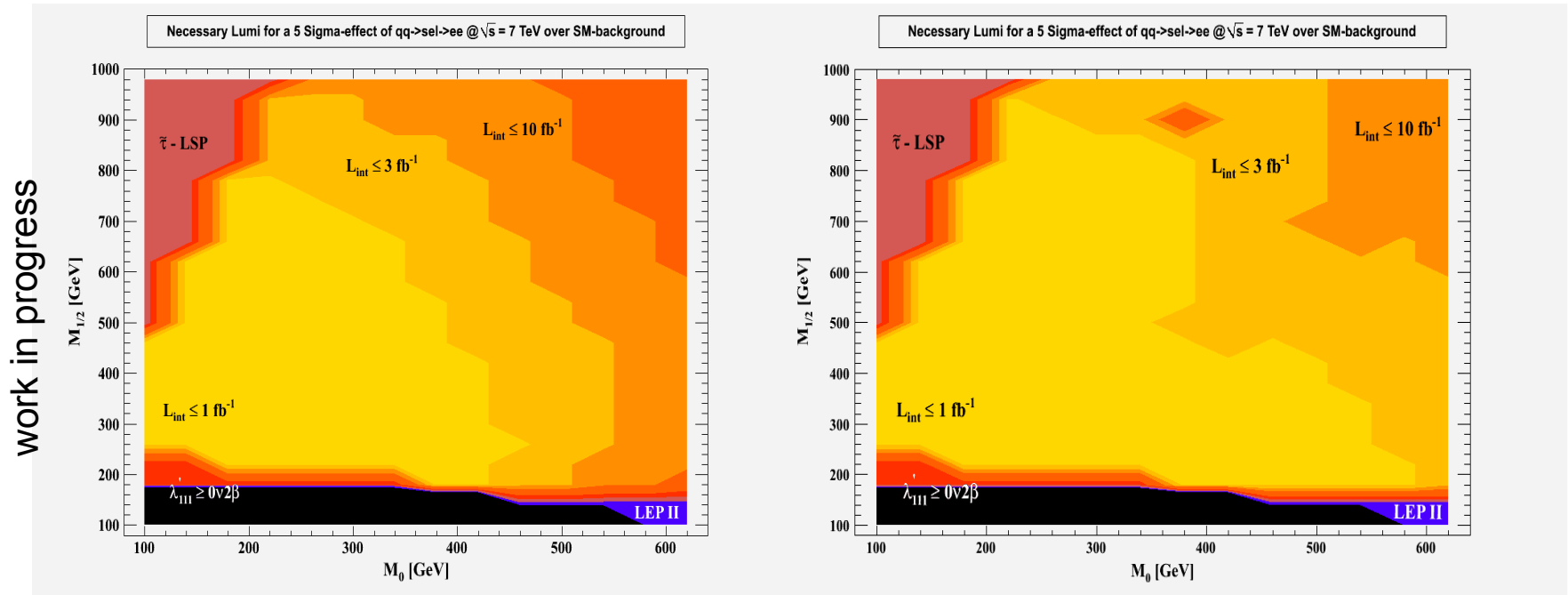
Cut improvement & Discovery Potential

- $M_0 - M_{1/2}$ scan on a 576 point grid
 - $\lambda'_{111} = 0.005$ at the GUT-scale; M_0 in 80 - 600 GeV; $M_{1/2}$ in 80 - 1000 GeV



Cut improvement & Discovery Potential

- $M_0 - M_{1/2}$ scan with improved cuts on a 576 point grid
 - $\lambda'_{111} = 0.005$ at the GUT-scale; M_0 in 80 - 600 GeV; $M_{1/2}$ in 80 - 1000 GeV



Conclusions & Outlook

- Analyses of like sign di-electron as a test for $0\nu 2\beta$ at early LHC stage
- No general cut for all mSUGRA-SUSY spectra
- Cut improvement works
 - High $p_{i\text{on}}$ hardest electron, p_{i2} nearly not relevant
 - „low“ $E_{\text{T}}^{\text{miss}}$ at small Neutralino masses (higher $E_{\text{T}}^{\text{miss}}$ in signal events)
- GUT couplings:
 - $\lambda'_{111} = 0.001$ (not shown) → no discovery; claim for evidence
 - $\lambda'_{111} = 0.005$ → discovery
 - $\lambda'_{111} = 0.01$ → discovery

Conclusions & Outlook

- TODO:
 - cross-check with more recent Tevatron results
 - closer look on the background
 - increase grid size
- LHC has the possibility to discover like sign di-electron signal from λ'_{111} at $L_{\text{int}} \leq \text{fb}^{-1} \rightarrow 0v2\beta$
- Thank you