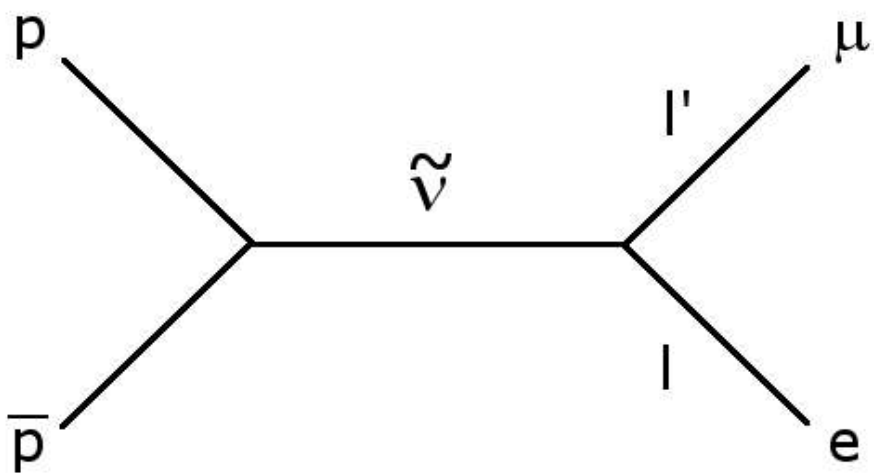
R-Parity Violating Sneutrino Decay

Kristian Hahn, Peter Wittich, Nigel Lockyer
University of Pennsylvania

07.06.04

Sneutrino Decay



- Sneutrino: neutral, scalar
- R-parity violating production & decay
- Lepton flavor violating decay
- Final State: High P_T muon & electron

Motivation - Theory

- Theory
  - R-parity : $R \equiv (-1)^{3(B-L)+2S}$, SM even & SUSY odd
  - Introduced to conserve baryon & lepton #
- Why RPV is not crazy ...
  - B & L conservation is 'accidental' in the SM
    - Not implied by gauge-invariance
  - Other arguments against RPV can be countered
    - Stable LSP: still possible with RPV?
    - Proton Decay: can't break *both* B and L

Constraints

- RPV SUSY Lagrangian couplings
  - $\lambda_{\mathbf{ijk}} : L_{\mathbf{L}}^{i} L_{\mathbf{L}}^{j} \bar{E}_{\mathbf{R}}^{k}$ (decay) , $\lambda'_{\mathbf{ijk}} : L_{\mathbf{I}}^{i} Q_{\mathbf{L}}^{j} \bar{D}_{\mathbf{R}}^{k}$ (production)
  - V. Barger, Phys. Rev. D **40**, 2987
    - $\lambda'_{311} < 0.11 \times m(\sim d_R)/100\text{GeV}$
    - $\lambda_{132} < 0.062 \times m(\sim \mu_R)/100\text{GeV}$, $\lambda_{231} < 0.070 \times m(\sim e_R)/100\text{GeV}$
    - $\lambda_{223} < 0.070 \times m(\sim \tau_R)$, $\lambda_{122} < 0.049 \times m(\sim \mu_R)/100\text{GeV}$

Motivation - Experiment

- Improve upon Run I analysis (Tamburello, note: 6415)
    - Larger CM energy
    - Higher luminosity
    - Increased acceptance
- e,μ signature is attractive
    - Clean, suppress SM backgrounds
    - Applicable to additional physics
        - ZZ
        - Z'
        - Horizontal gauge bosons, multiple Higgs doublets

Work Done So Far ...

- Check consistency with Run I analysis
  - Generate signal M.C., calculate α
  - Run on bg M.C., calculate α's
  - σ*BR, sensitivity

- Assessing improvements to the Run I analysis
  - Looking to increase signal acceptance ...

Monte Carlo

- Signal
  - CdfSim 4.9.1 / Pythia
    - Use H_0 to model the sneutrino
    - Force decay to e,μ
    - Generate at 50-800Gev
  - CdfSim & Production - 4.11.2
- SM Backgrounds (4.9.1/4.11.2)
  - DY(Z → τ,τ) : Pythia, 300K events
  - WW : ALPGEN, 162K events
  - Top : Pythia, 200K events

Event Selection

- Require >= 1 each “standard” electron, muon
  - Electrons: CES
  - Muons: CMUP, CMU, CMX
- No missing E_T or jet requirements
- Vertex : $\Delta Z < 5cm$
- Bin using 3 x inv. signal mass RMS (pg. 13)

Standard EWK/top Cuts

- electrons
  - **E_T >= 20 (25)**
  - **Axial Hits >= 3**
  - **Stereo Hits >= 3**
  - **P_T >= 10 (13)**
  - **Had/EM <= 0.055-(0.0045*E)**
  - **E/P <= 4 || P_T >= 50**
  - **Z_0 <= 60**
  - **ΔZ <= 5**
  - **-3.0 <= Q*ΔX <= 1.5**
  - **Lshr <= 0.2**
  - **Strip χ^2 <= 10**
- muons
  - **P_T >= 20**
  - **Had <= max(6,6+0.0280*P-100)**
  - **EM <= max(2,2+0.0115*P-100)**
  - **Z_0 <= 60**
  - **Axial Hits >= 3**
  - **Stereo Hits >= 3**
  - **abs(D_0) <= .20,TrkSiHits==0 || abs(D_0) <= .02, TrkSiHits!=0 (no Si reqs.)**

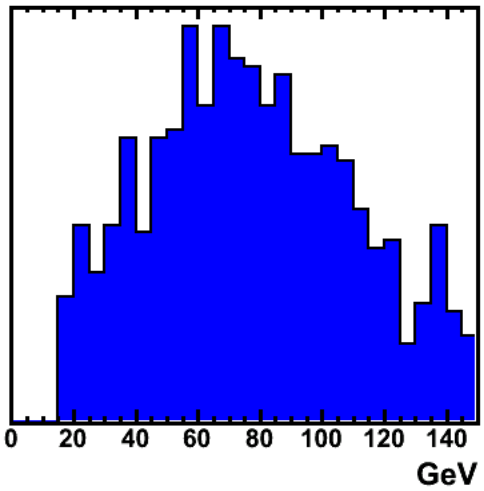
Acceptance - Signal

Mass (GeV)	Run 1 %	Run 2 %
50	2.2	8.3
100	15.2	18.7
200	22.5	22.2
300	28.3	26.3
400	31.6	28.7
500	35.2	29.1
600	37.5	27.9
700	39.2	32
800	40.5	31.5

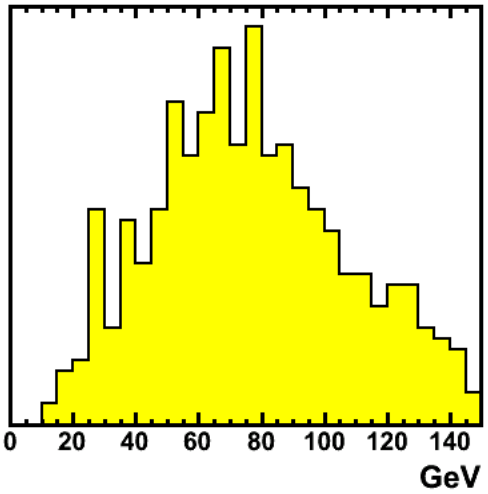
Acceptance - Background

Channel	Run 1 %	Run 2 %
DY	0.21	0.39
WW	2.83	3.12
Top	0.45	0.41

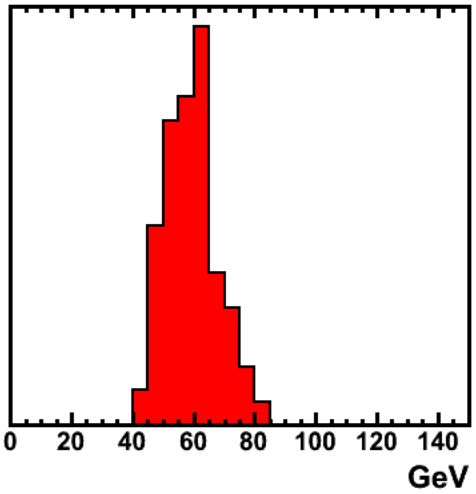
Background Mass Profiles



top



WW

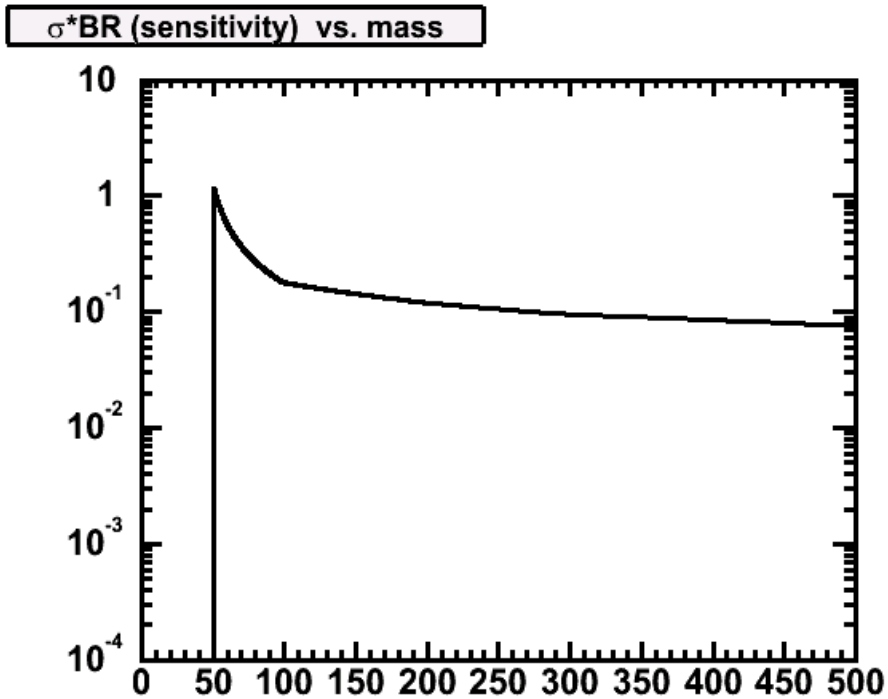


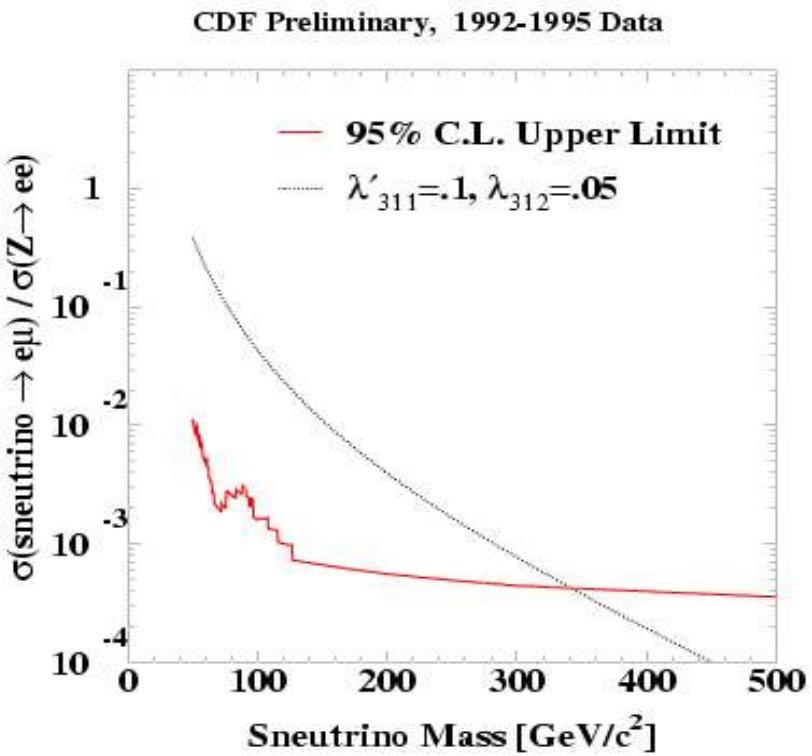
DY

Sensitivity (1)

- PDG: C.L. = 1 – Σ^{No} P(S+B)/Σ^{No} P(B)
- Interpolate α using bins of 3 x inv. mass RMS
- Count background for each bin (= μ_b)
- Assume null hypothesis, $N_o = \mu_b$
- calculate Σ^{No} P(μ_b , n)
- Solve for μ_s in Σ^{No} P(μ_s+ μ_b , n) @ 95% C.L.
- $\mu_s \Rightarrow \sigma_{br}$

Sensitivity (2)





(much) To Do

- Rerun MC with 5.3.X
  - WW bg : Alpgen ⇒ Pythia (include spin correlations)
- Investigate possible modifications (next slide)
- Include taus (& missing E_T)
- Account for fakes
- Include systematics
- Theory curve for 2TeV

Possible Changes ...

- Exotics cuts for leptons
  - More efficient at high Pt
- Lepton + track
  - Second lepton is an isolated track
  - Top group found an acceptance gain
  - Single prong hadronic taus
- Include phoenix electrons