R-Parity Violating Sneutrino Decay

Update for the Penn Group Mtg.

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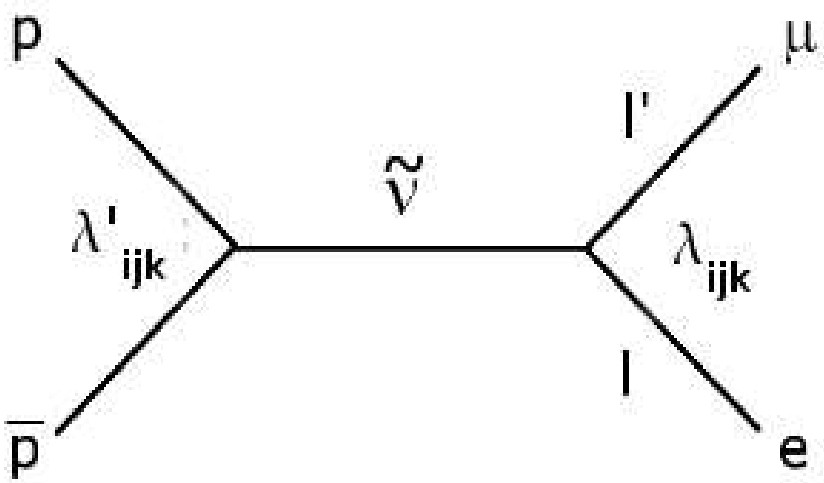
RPV Sneutrino



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

RPV Review

- 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
    - Proton Decay: can't break *both* B and L
    - Stable LSP: still possible with RPV?
  - Mechanism for neutrino oscillations?

Constraints

- RPV SUSY Lagrangian couplings
  - $\lambda_{\mathbf{ijk}} L_{\mathbf{I}}^{i} L_{\mathbf{L}}^{j} \bar{E}_{\mathbf{R}}^{k}$ (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 RunI analysis
  - Larger CM energy
  - Higher luminosity
  - Increased acceptance
    - Will include hadronic tau decays ...
- e,μ signature is attractive
  - Clean, suppress SM backgrounds
  - Applicable to additional physics
    - ZZ, Z'

Work Done So Far ...

- Finished
  - Generate signal MC (50-800 GeV), calc. acceptances
  - Calculate SM BG contributions
  - Cross Check lepton ID, Z control regions
  - Estimate RunII sensitivity

- In progress ...
  - Estimate fake lepton contributions
  - More cross checks (fakes & control)
  - High Pt lepton cuts for higher acceptance?

Monte Carlo

- Everything in cdfsoft 5.3.3_nt5
- Signal
  - CdfSim / Pythia
    - Use H_0 to model the sneutrino
    - Generate at 50-800Gev, force decay to e,μ
  - Production / TopNtuple via top group's official tarball
- SM Backgrounds
  - DY(Z → τ,τ) : Pythia, 2M events
  - WW : Pythia, 400K events
  - Top : Pythia, 1.2M events
  - WZ : Pythia, 400K events
  - ZZ : Pythia, 400K events

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 <= 2 || 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.)**

Red indicates a differing Run-I cut

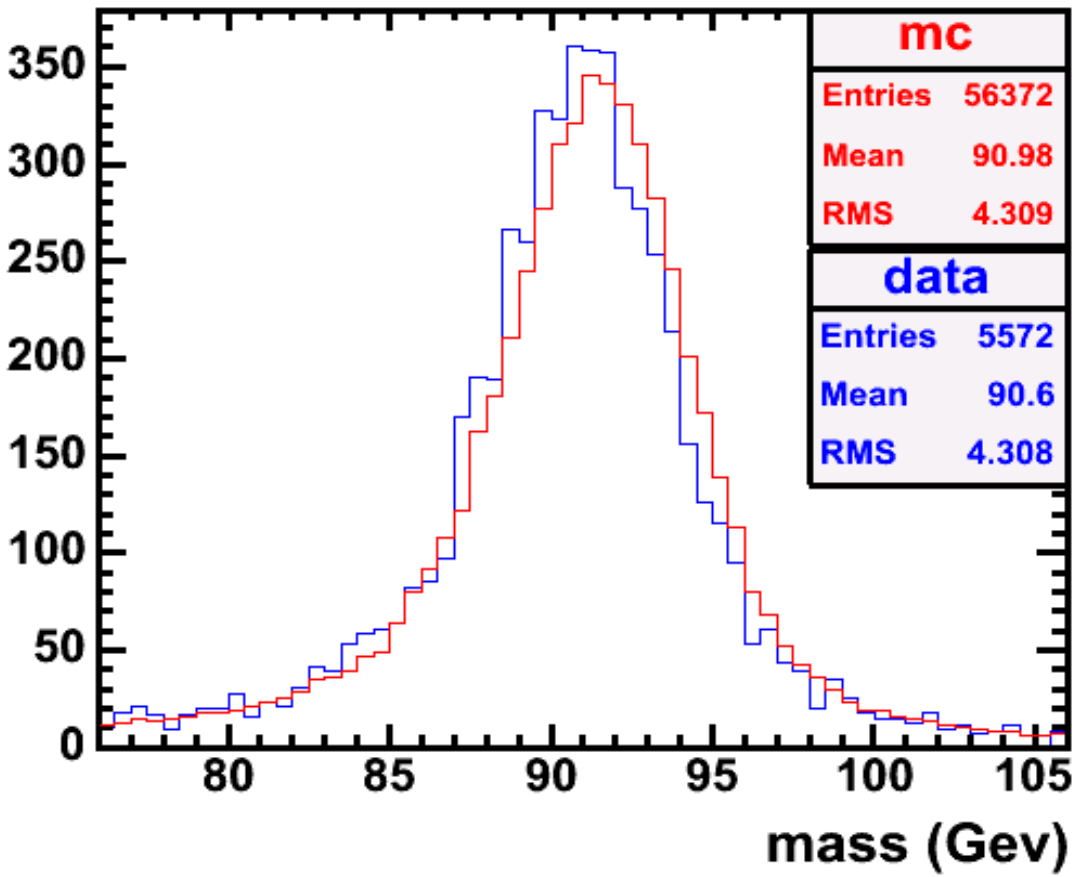
Event Selection

- Require >= 1 each “standard” electron, muon
  - Electrons: CEM
  - Muons: CMUP, CMU, CMP, CMX
- No missing E_T or jet requirements
- Opposite Charge
- Vertex : $\Delta Z < 5cm$

DY Control Regions

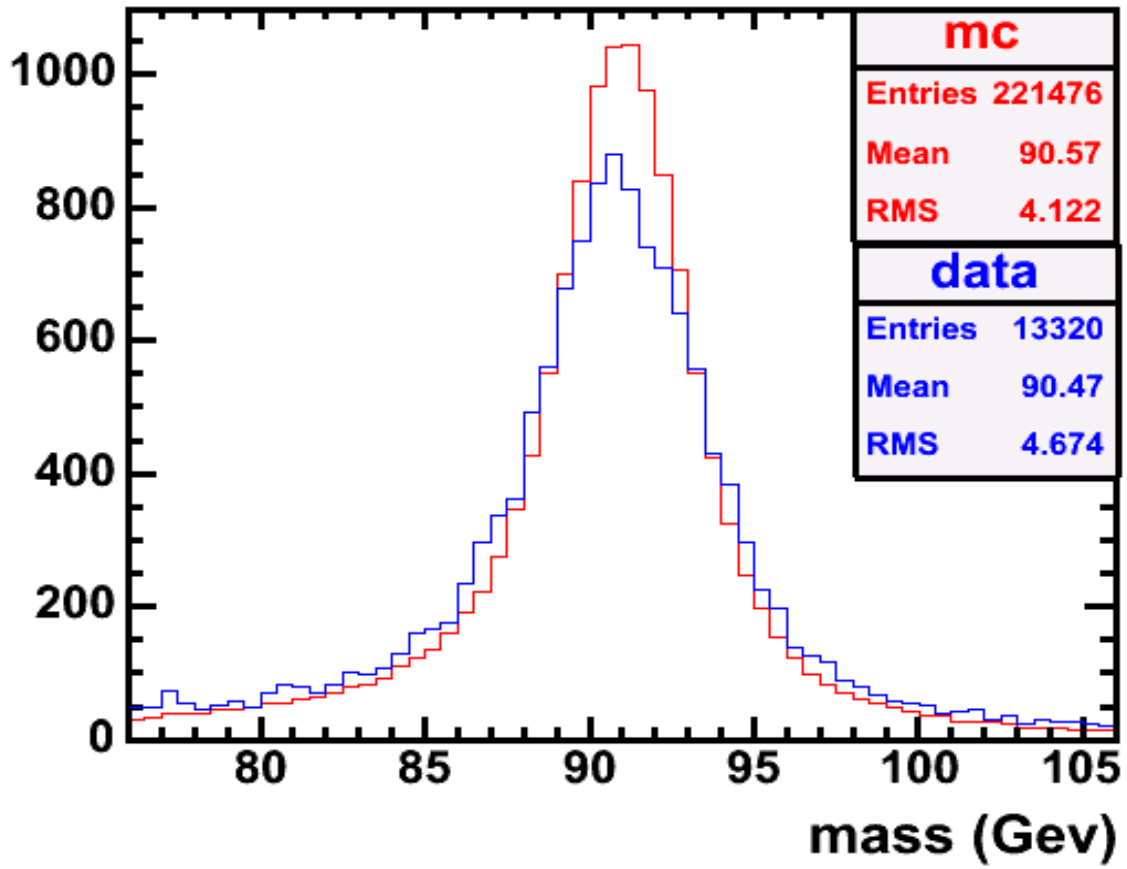
- Selection
  - Apply the analysis cuts to individual leptons
  - Apply usual ΔZ<5cm & oppQ analysis cuts
  - Require either 2 e's or 2 μ's
  - 76< mass < 106
- Acceptance
  - Measure in DY Monte Carlo
  - Cut at 66< HEPG dimass <116 to remove continuum contribution
- Data
  - Apply DQM-v7 good run list to inclusive lepton dataset
  - Problem getting 5.3.3_nt lumi's, no cross-sections yet

5.3.3_nt Z→ee



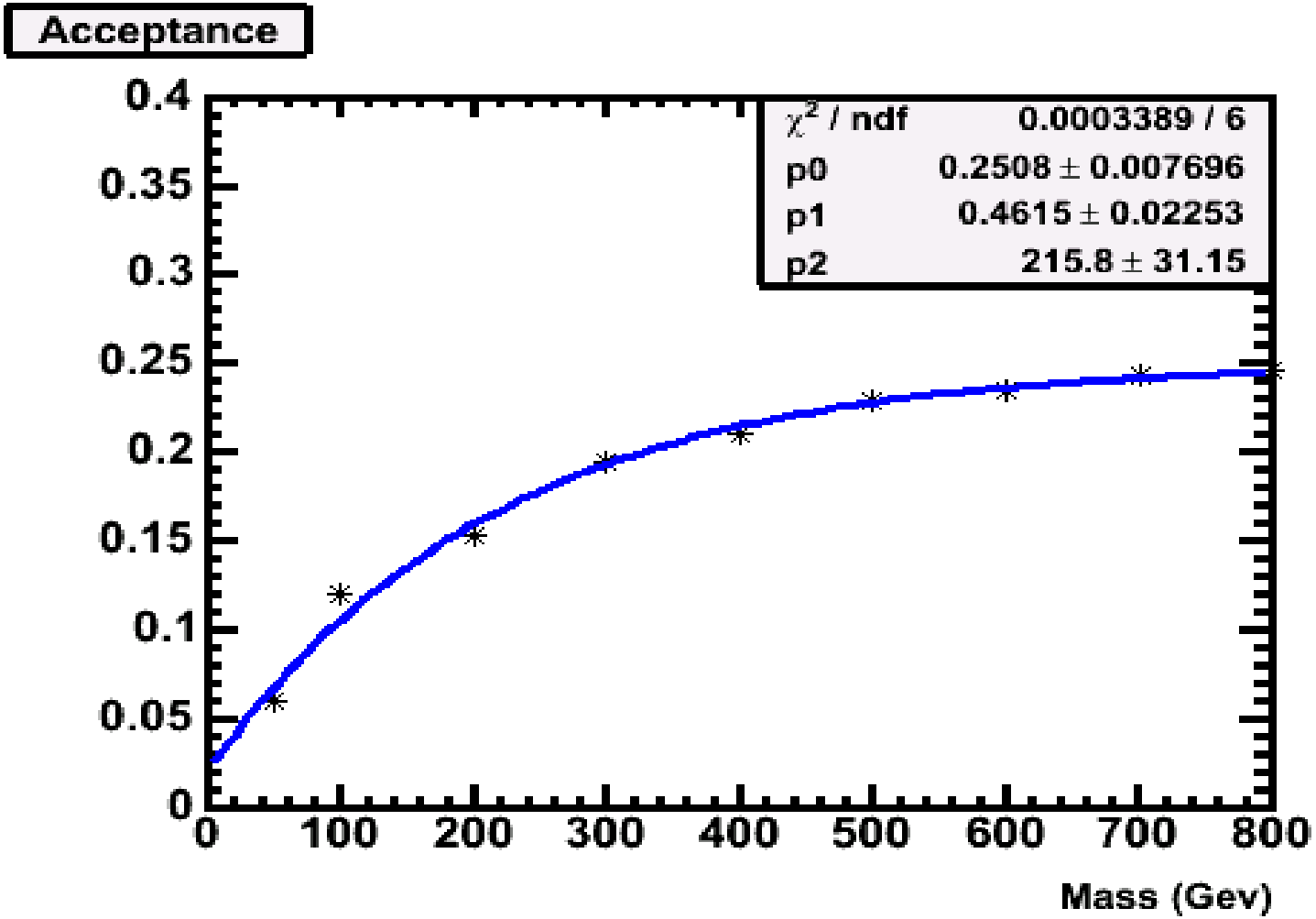
- No σ*BR yet ...
- MC: DY→ee, sample: ztop2i
- Data: highpt inclusive electron (CEM18), sample: bhel0d

5.3.3_nt Z→$\mu\mu$

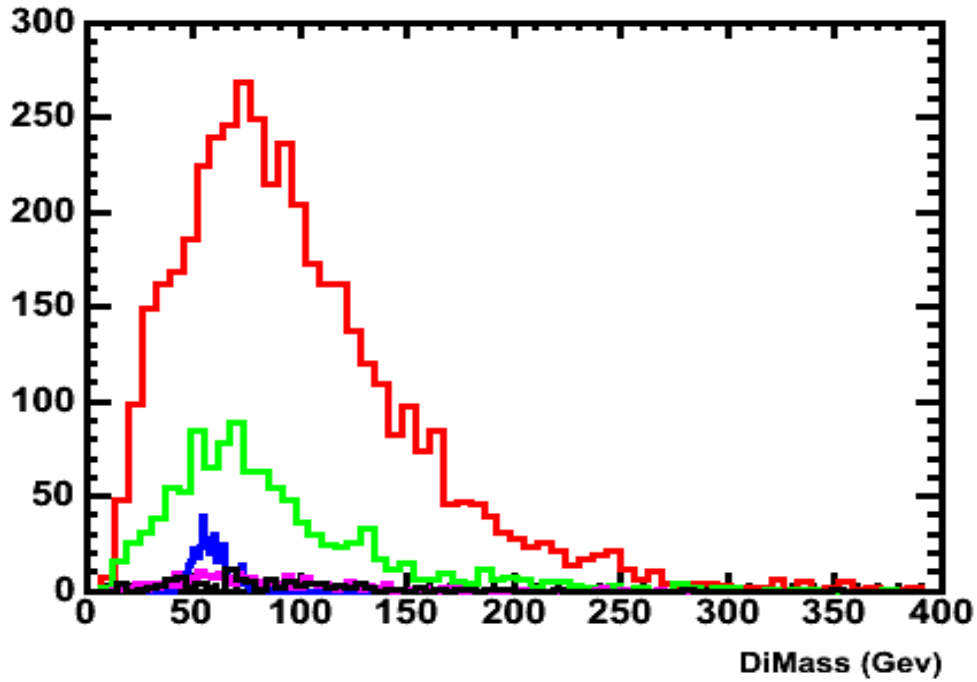


- Cosmic removal cut applied, no σ*BR yet ...
- MC : DY→$\mu\mu$, sample: ztop0i
- Data: inclusive highpt muon, (CMUP18 or CMX18), sample: bhm0d

Signal Acceptance



Background



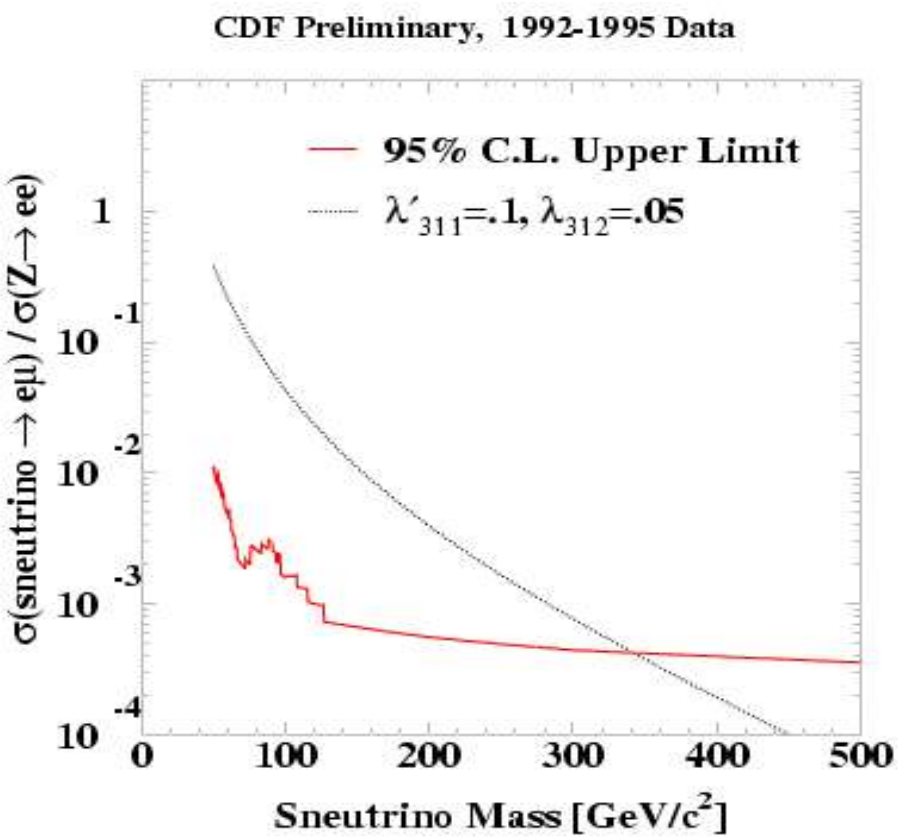
Channel	Acceptance (%)	CS x BR (pb)	Tot. Expected
DY	0.38 ±0.08	25.1	34.34
WW	3.07 ±0.08	0.24	2.65
Top	0.39 ±0.01	8.6	12.1
WZ	4.75 ±0.20	0.12	2.05
ZZ	3.38 ±0.32	0.14	1.71

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.
- $\mu_s \Rightarrow \sigma_{br}$

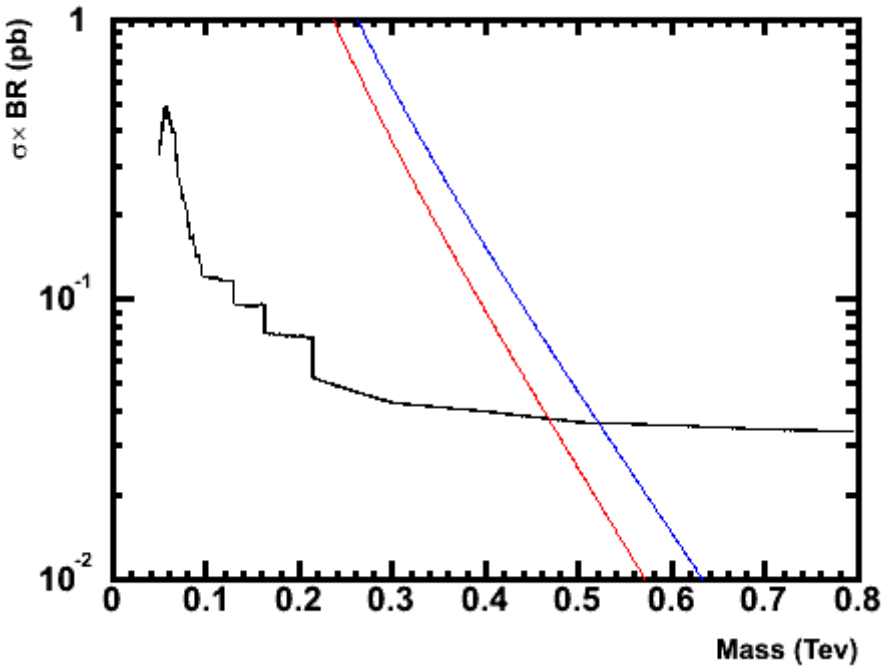
Sensitivity (2)

Run I Limit



RunII, assuming ...

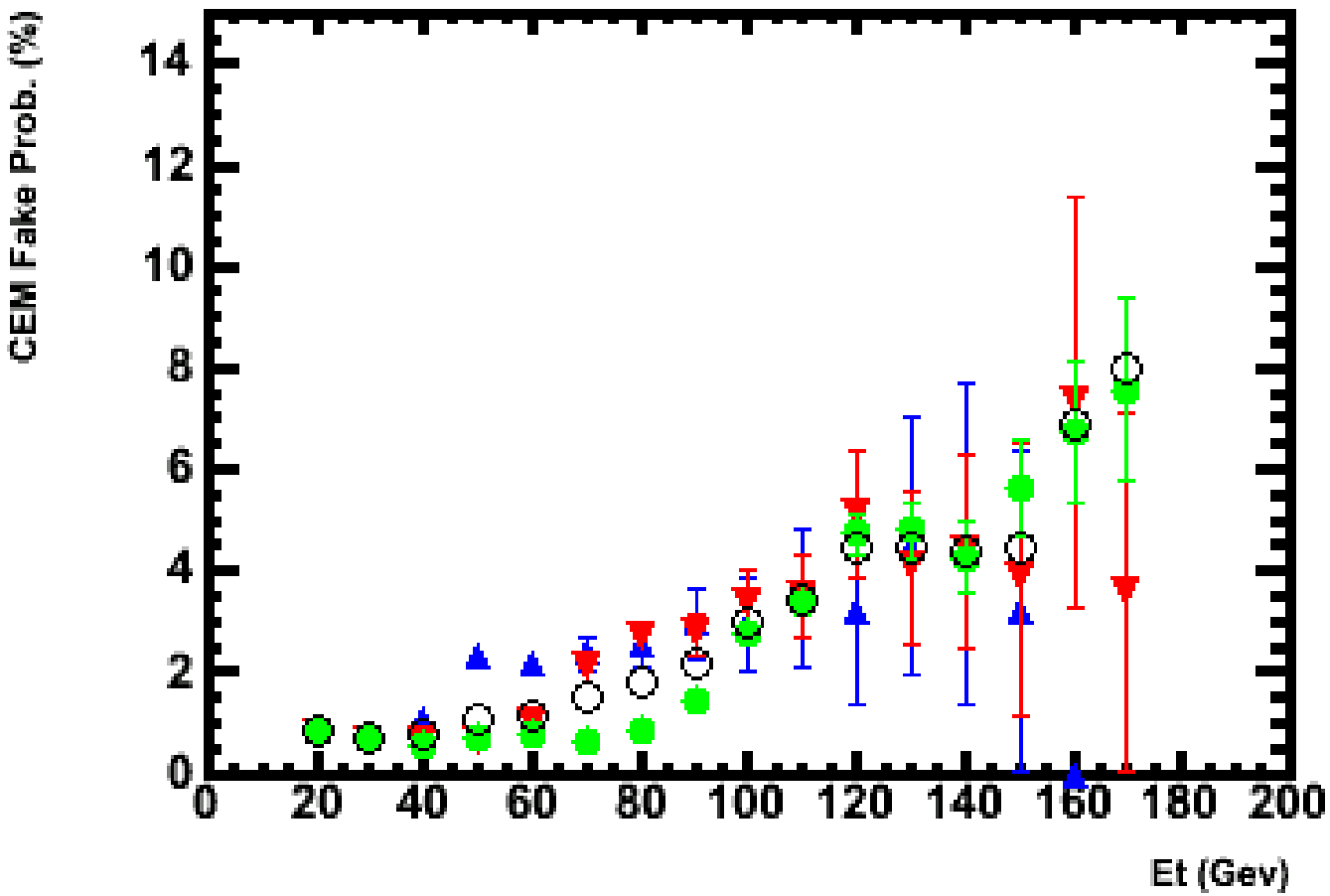
- Null Hypoth.
- 2 TeV
- 360 pb-1
- no fakes



Fake Rates

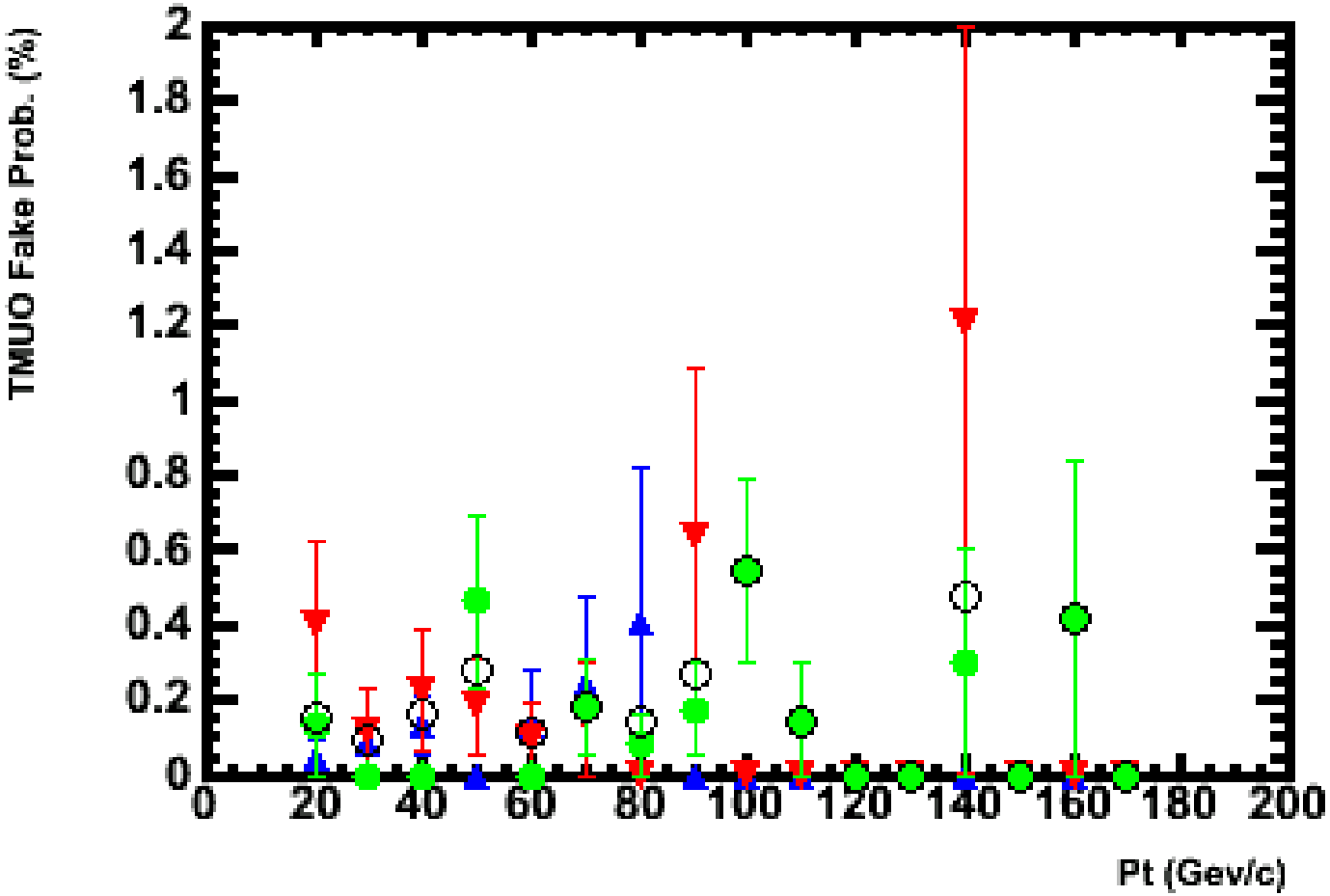
- Following top-dilepton's “fakeable” object approach
  - Electron fake ratio
    - Jets that fake electrons will give low Ehad/Eem.
      - Denominator: CdfEmObjects w/ Ehad/Eem < 0.125 (& Et >20?)
      - Numerator: CdfEmObjects passing tight cuts
    - Et dependent
      - Parameterize using Et and Isolation (to distinguish jet energy)
  - Muon fake ratio
    - Jets that fake muons yield a min. ionizing track
      - Denominator: CdfMuons w/ E/P < 1
      - Numerator: CdfMuons passing tight cuts
    - Pt dependent
      - Parameterize using Et and Isolation (to distinguish jet energy)
  - Benefits
    - Approach ensures that numer. is a subset of the denom.
    - Restricts fakerate definition to objects capable of faking leptons

Fake Probabilities - CEM



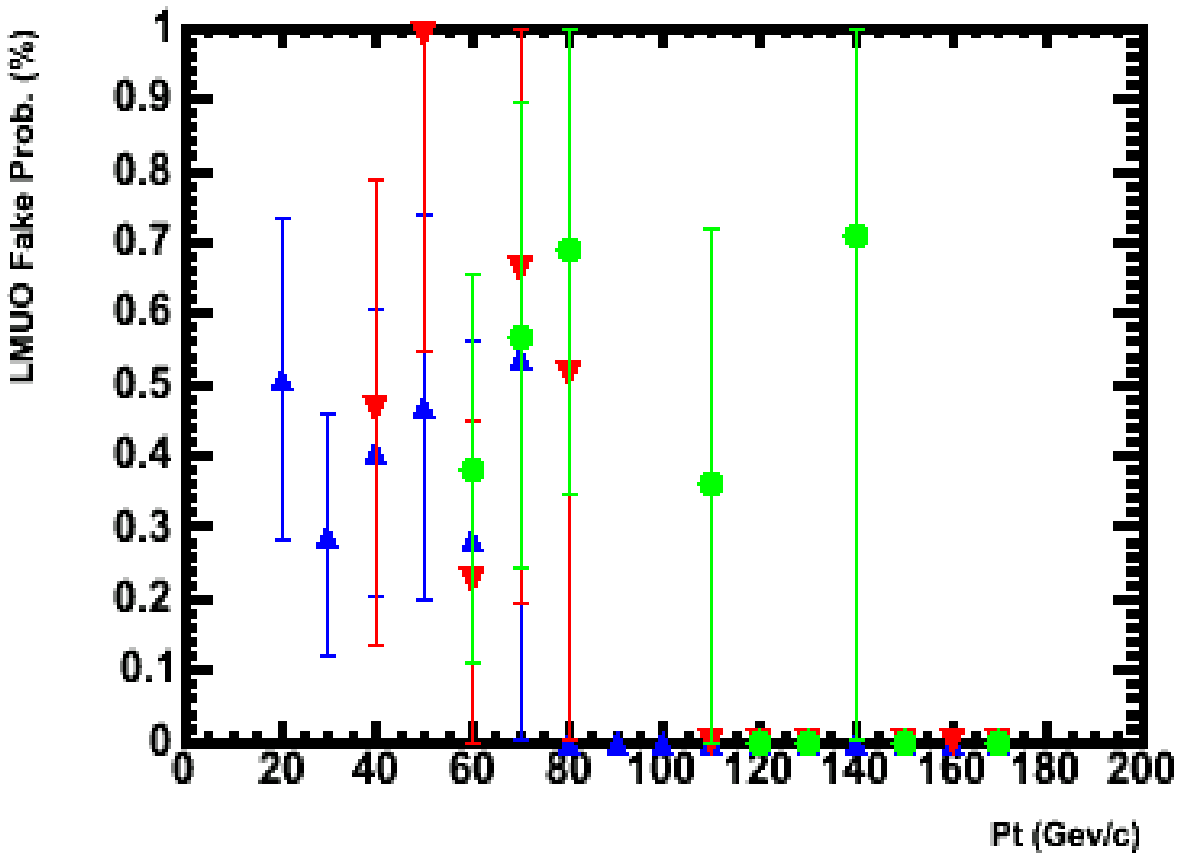
Jet20, Jet50, Jet70, Jet100

Fake Probabilities - CMUP+CMX



Jet20, Jet50, Jet70, Jet100

Fake Probabilities - CMU+CMP



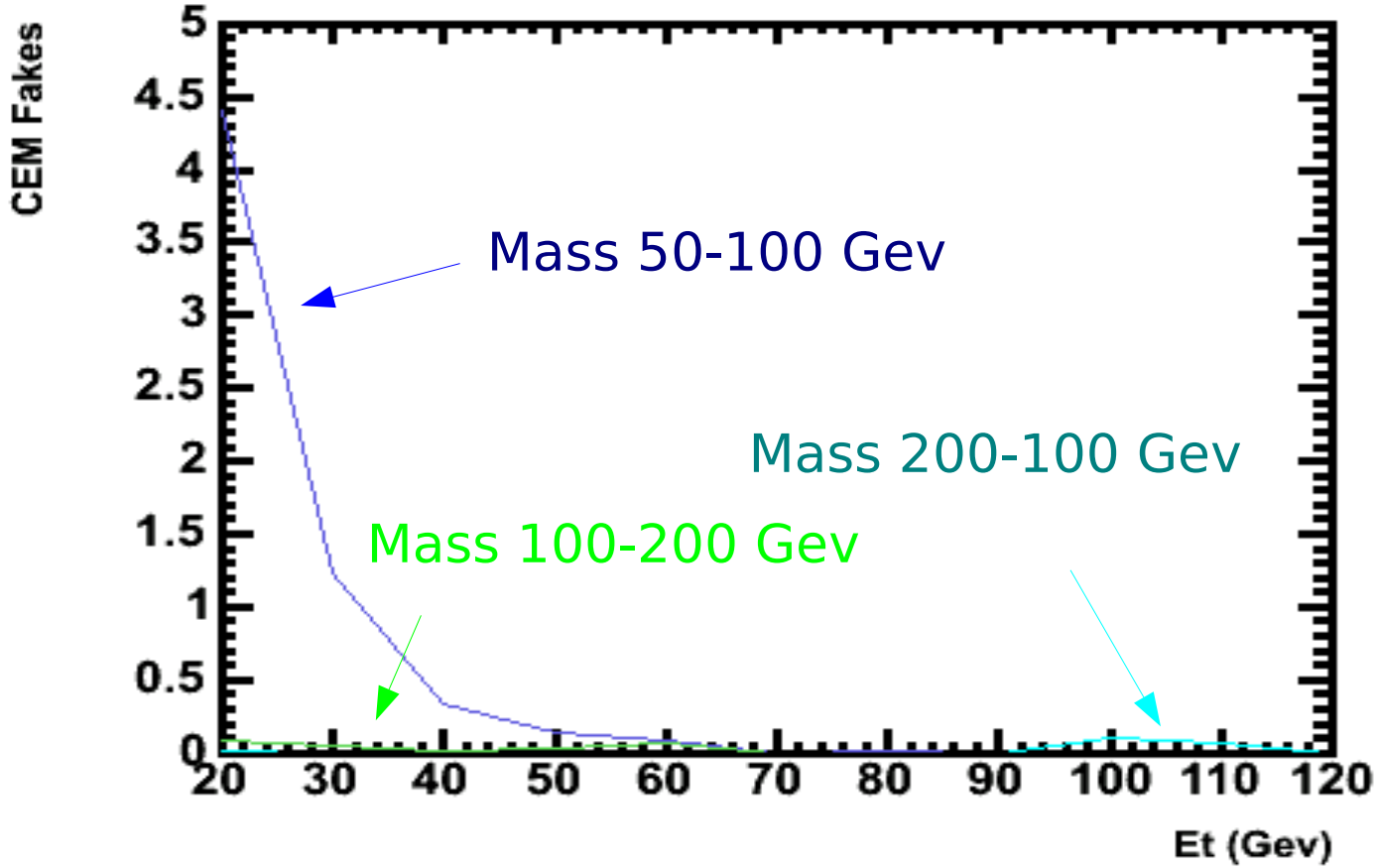
Jet20, Jet50, Jet70, Jet100

Fake Estimates

- Select events from data that fail signal selection, remain “blinded”
  - Using inclusive highPt lepton samples
  - Events w/ 1+ good lepton & N flavor different denominator objects that didn't pass full ID cuts.
- Skip Z's (oppq, 76<mass<106) & W's(Met>20)
- Bin denom objs. in Et/Pt and apply fake probs.
- Form real+fake Inv. Mass, 100Gev bins

- RunI estimates – different approach
  - Fake electrons: 1.42, Fake muons: 1.41

Fake Estimates - CEM



Total CEM fakes (from bhm0d) : 6.63

Conclusions

- Full status report nearing ...
  - Complete muon fake rates
  - Add fakes to sensitivity
  - More control regions
  - Investigate high Pt lepton cuts
  - Systematics
- e,tau & mu,tau in another analysis
  - RunI, leptonic taus only (e-mu final state)
  - Will use single prong hadronic taus