Susy search at CMS in leptonic analyses

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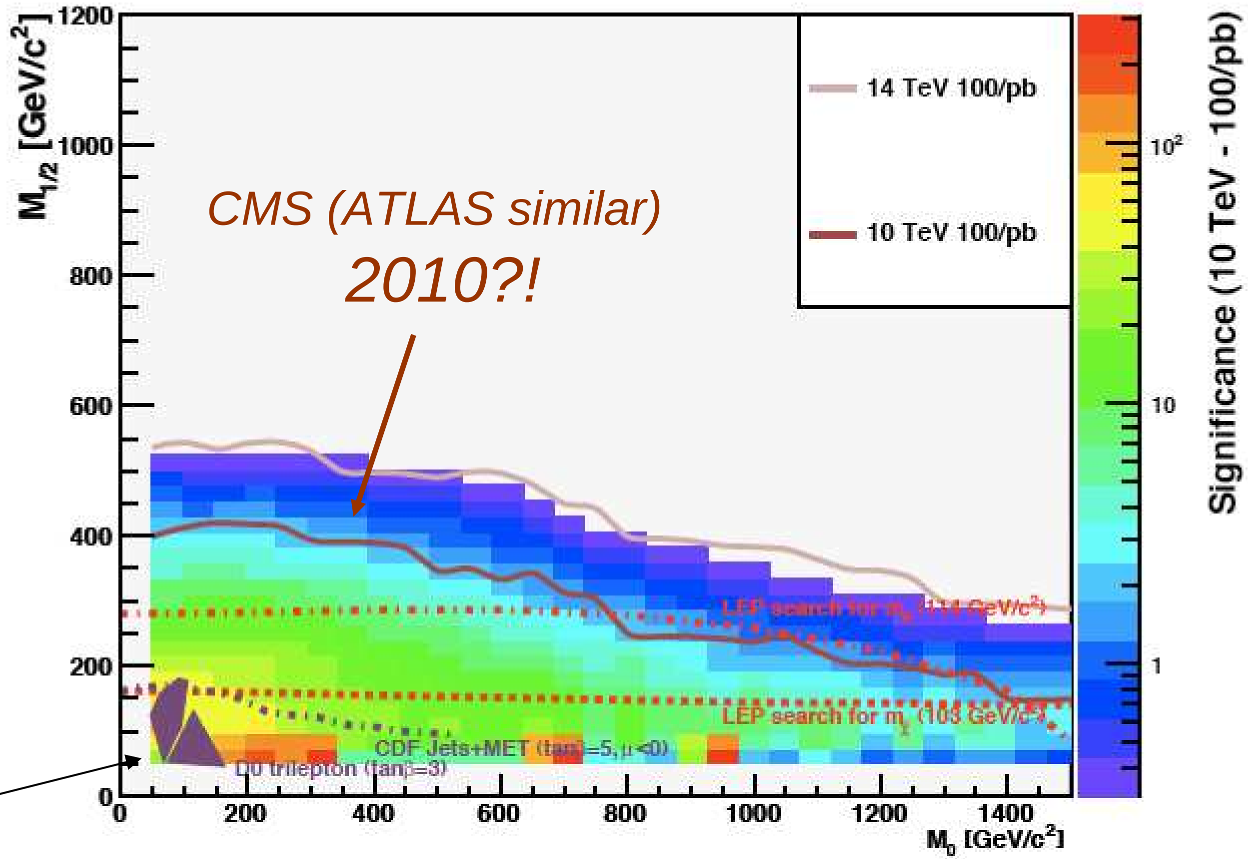
Summary:

- Imperial College involvement in leptonic analyses
- Open questions about trigger and selection
- What can we learn from dilepton analyses?
- Conclusions

Expectations @ LHC



Tevatron
Today

With ~100/pb @ 10 TeV of (understood!) data we should be able to go significantly beyond the reach of the Tevatron!

Introduction

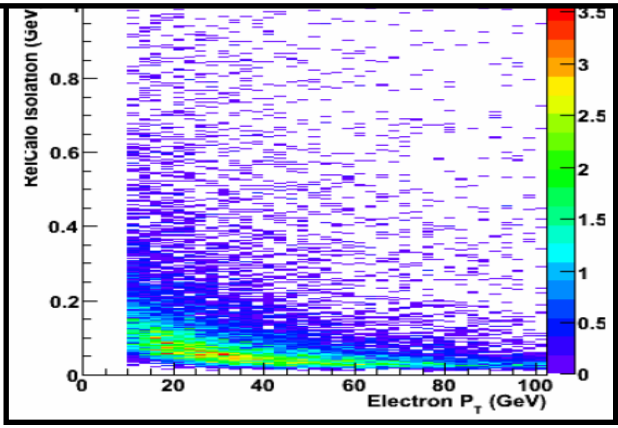
- SUSY analyses in CMS will initially look for data excess wrt SM prediction. (Model independent approach)
- SUSY analyses classified by looking at final topology
- IC-CMS group is actively involved in 3 leptonic SUSY analyses
  - Single Lepton + Jets + MET
  - Dilepton Opposite sign + Jets + MET
  - Dilepton Same sign + Jets + MET
- Use of benchmark points (mSugra and GMSB) to test analysis sensitivity in different SUSY scenarios

Common approach to leptonic analyses

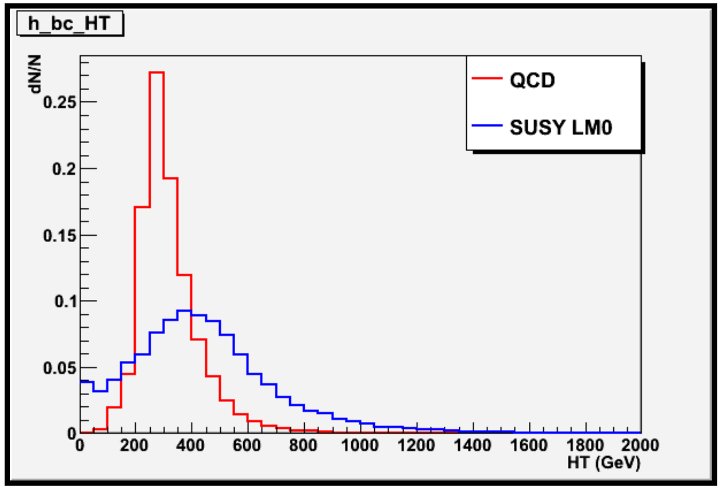
- In order to have consistent approach for the search of SUSY phenomena, common variables and common tools have been defined for all the leptonic analyses:
  - Lepton selection
  - Event's variable definition
  - Background estimation method
  - Analysis framework

Common variables

Since the pt spectrum of leptons from SUSY is unknown, the μ/e reconstruction and identification is tuned to select also low pt leptons (pt<15 GeV).



HT = $\Sigma Pt_{jet}+\Sigma Pt_{lep}+\Sigma Pt_{\gamma}$
HT describes the visible energy in a pp→Susy particles interaction

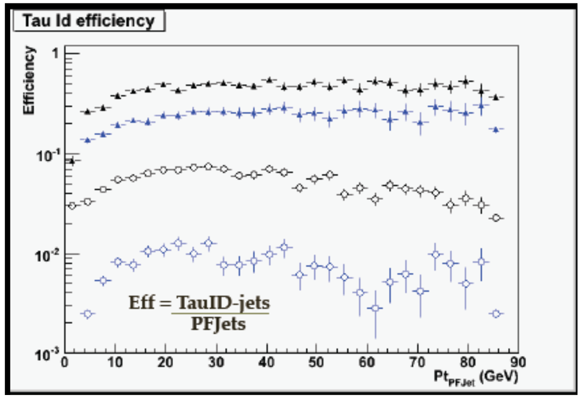


The requests for tau reconstruction are:

1. Low QCD misidentification
2. Robustness vs detector effects in the first data
3. Efficiency at low pt
4. Negligible mis-charge measurement

Standard τ id

Susy τ id

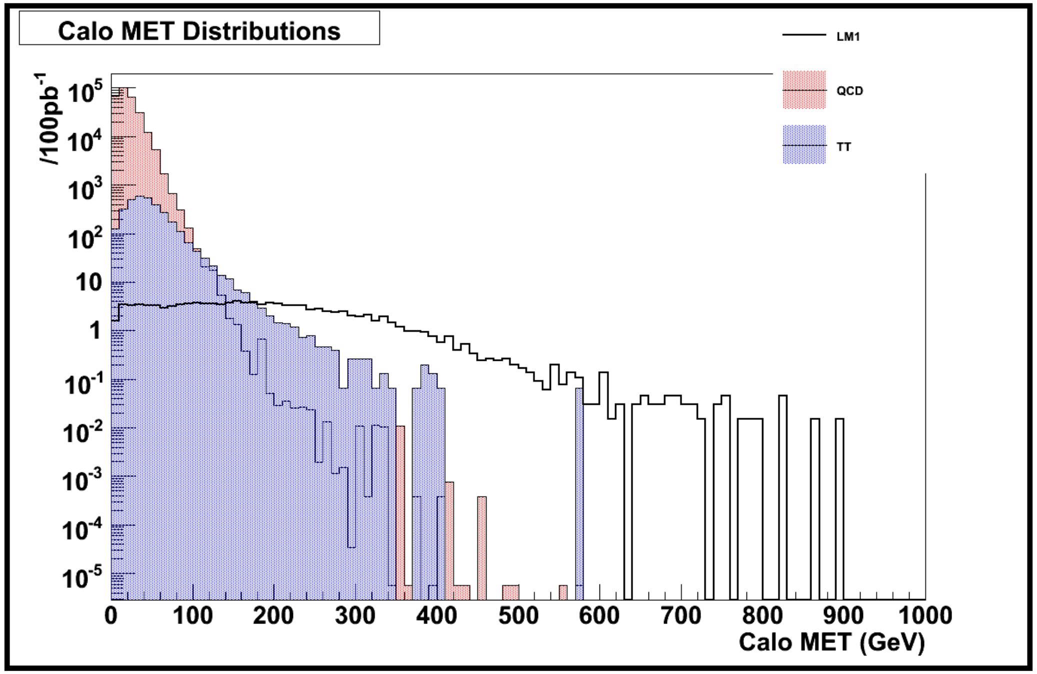


Single Lepton

Selection:

- **1 electron/1muon**
- **Veto on additional lepton**
- **3 jet (Et>50GeV)**
- **MET>100 GeV**

MT(lep,MET) under study



μ channel

Sig_{exp} (LM0,100 pb^{-1}) ~ 400

e channel

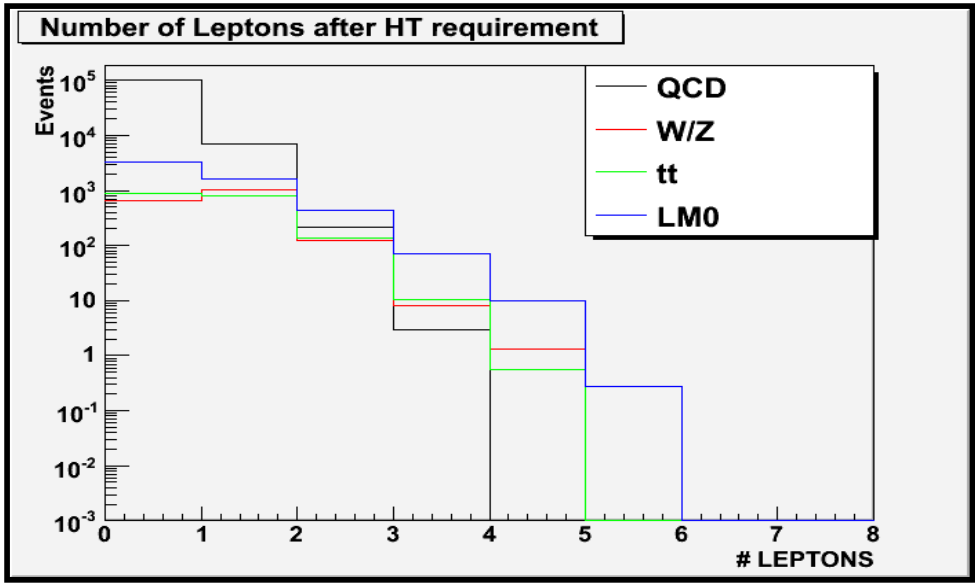
Sig_{exp} (LM0,100 pb^{-1}) ~ 380

Bkg_{exp} (100 pb^{-1}) ~ 160

DiLeptons

Selection:

- HT>350 GeV
- Number of leptons(e,μ,τ) >=2
- Ch(lep1)*Ch(lep2)>0 for same sign (<0 for opposite sign)



Same sign

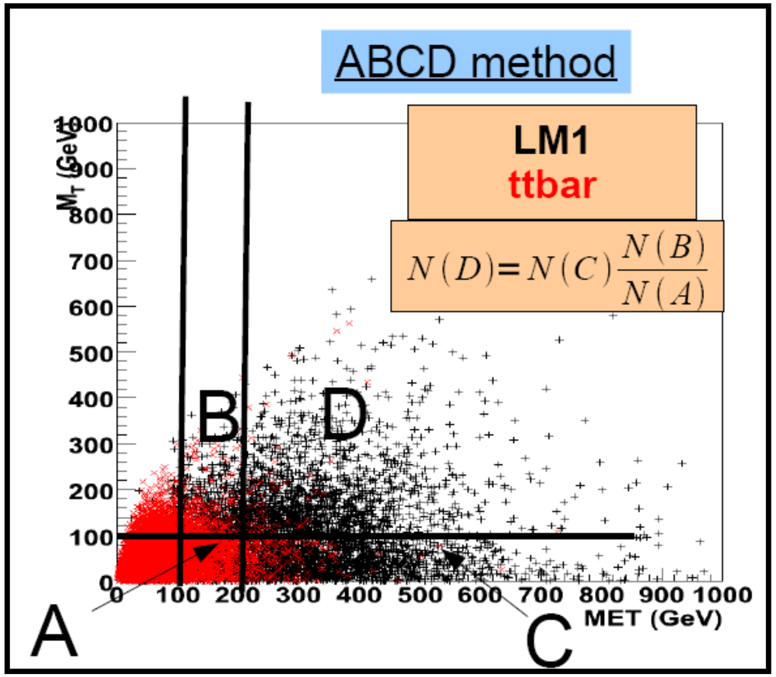
Sig_{exp} (LM0,100 pb^{-1}) ~ 130

Bkg_{exp} (100 pb^{-1}) ~ 50

For opposite sign both signal and background are higher

Background evaluation

ttbar is the dominant background for leptonic susy searches



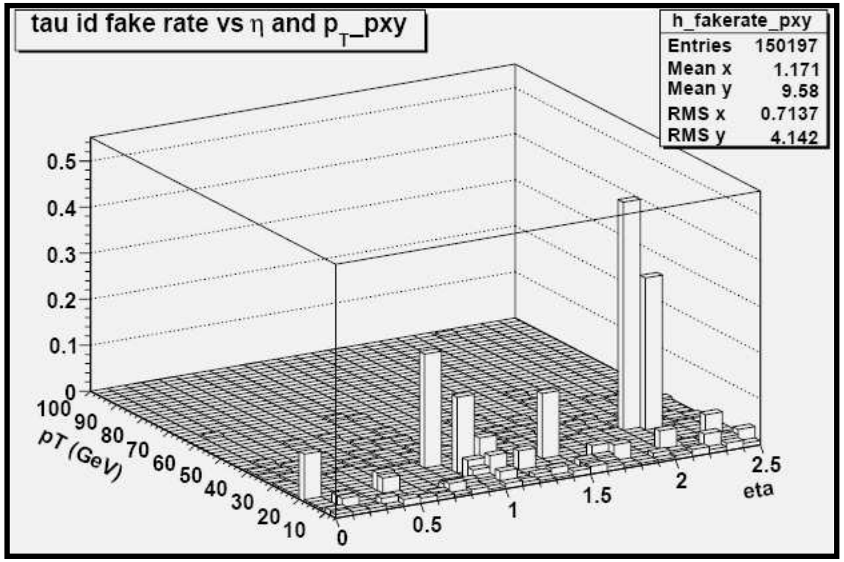
N(tt) expected	**16±2**
N(tt) estimated	**18±2**

Tau Fake Rate

Find a τ-free control sample:

Minimum bias events

(τ contamination ~0.1%)



Use fake rate map in final states with similar topology

Trigger issue

Two trigger strategies under investigation:

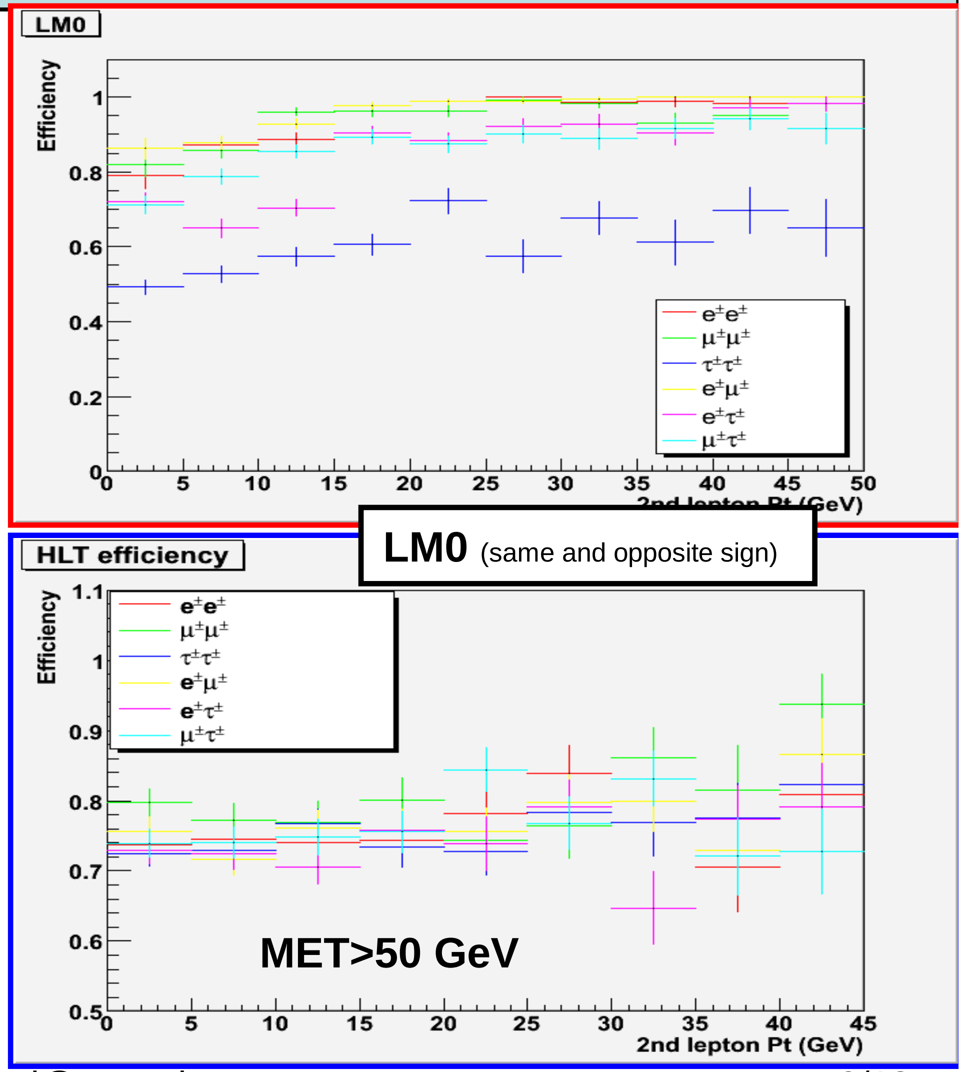
- Leptonic trigger

  More reliable at the start-up. Each final state must be triggered with a different trigger path.

- Hadronic trigger

  More efficient if the lepton spectrum is soft

  The efficiency is slightly dependent on the lepton flavor



Open question about selection

- Theory:
  - Missing energy request (trigger and/or reconstruction) implies the presence of an invisible LSP
  - In order to have an observable related to the energy scale of Susy processes, What is the most correct definition for HT? Should photons, leptons, MET be included?
  - HT: a request on the visible energy produced in the Susy particles decay implies the fraction of energy to invisible particles is low
- Experimental issue:
  - Lepton pt range: below certain pt threshold the possibility to measure fakes from data becomes hard

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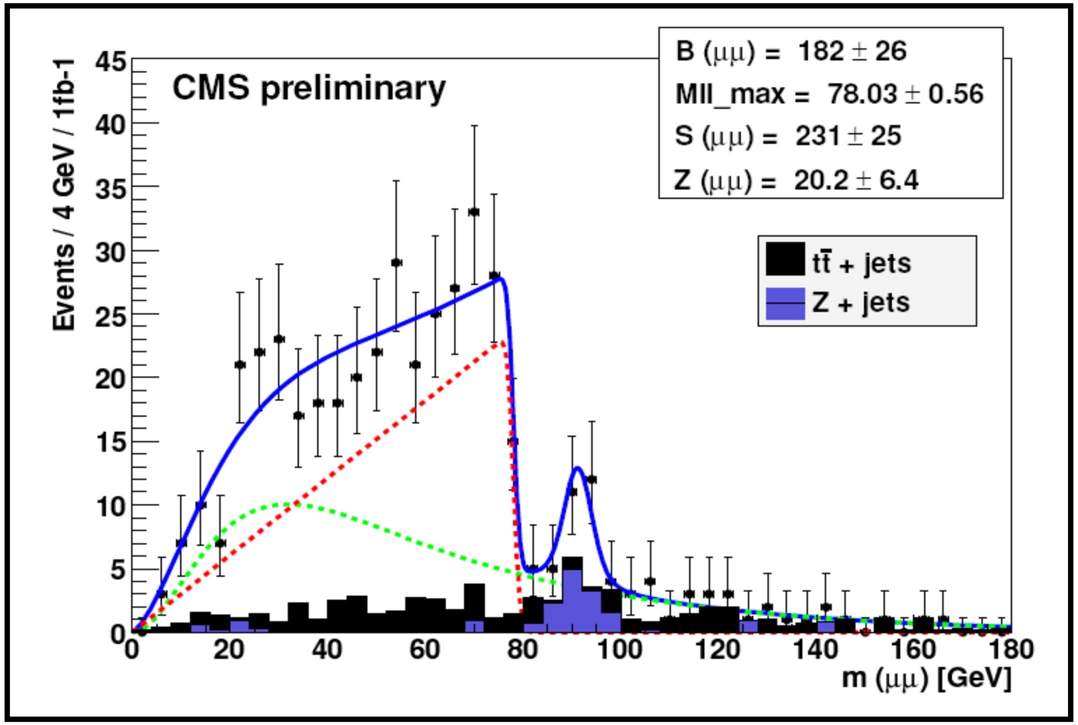
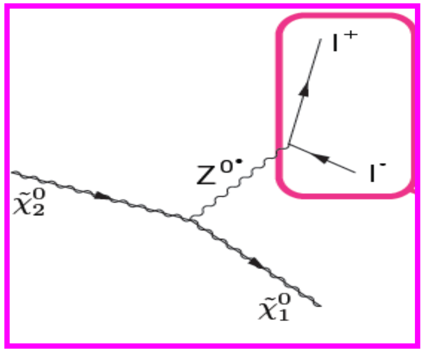
Dilepton opposite sign: the edge measurement



In some SUSY models the dilepton (opposite sign same flavor) invariant mass is the difference in mass between 2 susy particles.

$$\tilde{q}_L \overset{31\%}{\longrightarrow} \tilde{\chi}^0_2 q \overset{12.7\%}{\longrightarrow} \tilde{\ell}^{\pm}_R \ell^{\mp} q \overset{100\%}{\longrightarrow} \ell^{\pm}\ell^{\mp}\tilde{\chi}^0_1 q$$

Can we disantangle 2-body and 3-body decay contribution?



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What can we learn from SSDL?

- Find the compatible SUSY scenarios by looking at relative yields in the 6 dilepton same sign final states
  - Under the assumption of SSDL from same sign charginos, the relative yield in the 6 final states is proportional to the Br($\chi^+ \rightarrow l_1$ +X)* Br($\chi^+ \rightarrow l_2$ +X)
  - Can we associate the relative yield (e.g N($\tau\mu$)/N($\mu\mu$)) to some fundamental parameters of SUSY models?
- (++) – (--) events gives access on the relative production of squark and antisquark (dependent on the LHC energy)

Conclusions

- The 3 analyses are promising and can see new physics (or exclude models) with 100 pb^{-1}
- A common approach guarantees the consistence of results
- Bkg evaluation from real data is the key of these analyses
- Do the cuts applied favor some SUSY models or scenario?
- What else can we learn from leptonic SUSY analyses?