# Discovery potentail and possible study after discovery

March 21st, 2007 @ SUSY WG meeting during T&P week

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# Outline

- SUSY discovery potential
  - Introduction
  - Software and dataset
  - Result in mSUGRA
- Inclusive study after discovery
  - Introduction / Motivation
  - Software and dataset
  - Studied variables
- Summary and Outlook

# SUSY Discovery Potential in mSUGRA ($L=30fb^{-1}$)

# Introduction

## At discovery phase

- SUSY signature will be searched by inclusive way, so called 0,1 and 2-lepton mode.
- Background should be estimated using real data. (these uncertainties are not available now)

Show result with optimized 0,1 and 2-lepton mode analyses for the integrated luminosity of 30fb$^{-1}$ including systematic uncertainties of background event generation.

More detailed report (for L=1fb$^{-1}$) was presented by Kenta.
http://indico.cern.ch/conferenceDisplay.py?confId=7748

# Data sample & Selection

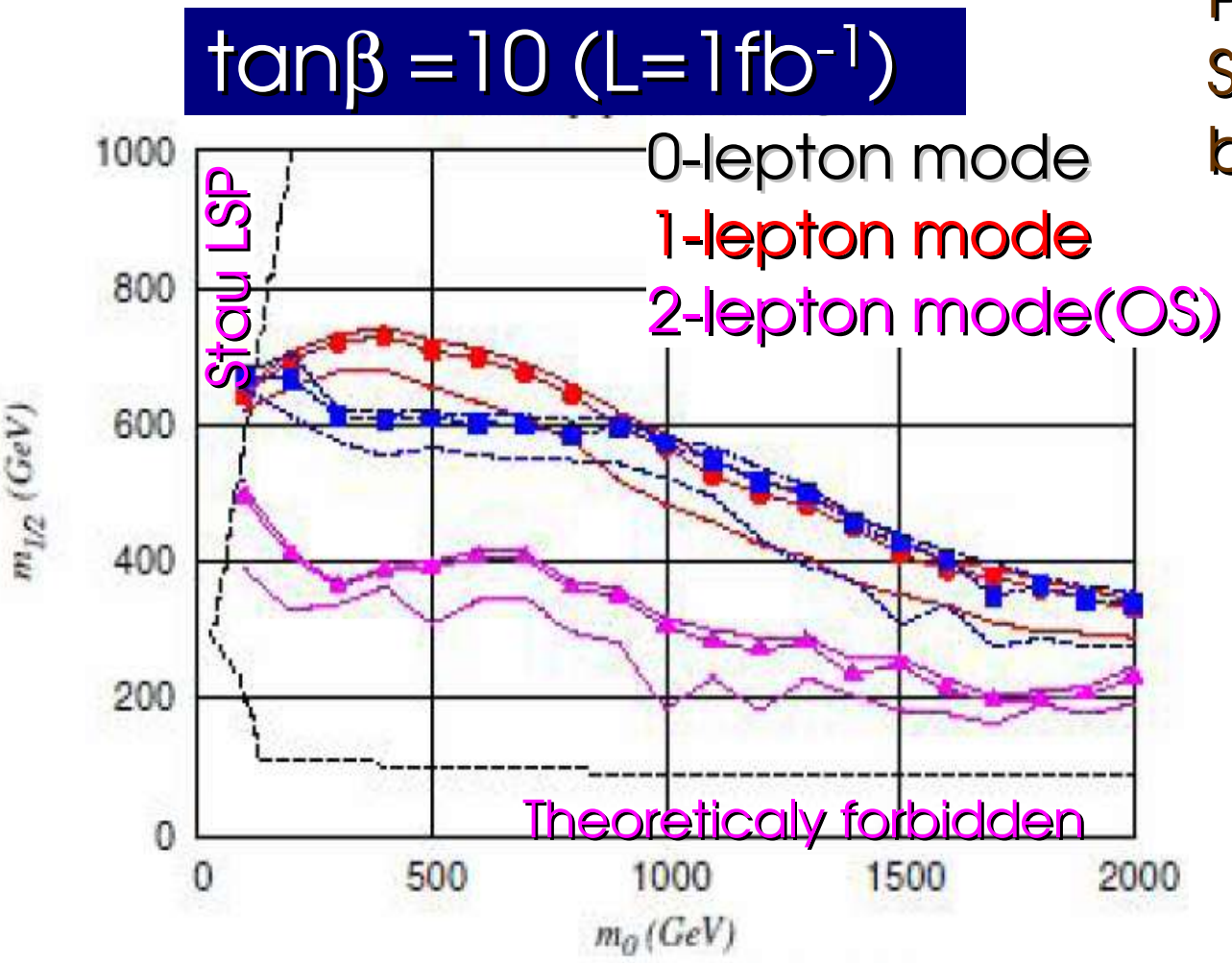
## Data Sample

- SUSY signal event generation : ISAJET7.71 + Jimmy
- Background event generation : Alpgen2.05 + Jimmy
- Fast simulation : Atlfast (rel11.0.5)

## Optimized selection

| variable | standard cut | scan ( min, max, step ) |
|---|---|---|
| MET | > max(100GeV,0.2Meff) | (100,1000,100) GeV |
| # of jets | ≥ 4 | |
| $P_T^{jet}(1^{st})$ | > 100GeV | (50,500,50) GeV |
| $P_T^{jet}(4^{th})$ | > 50GeV | (50,500,50) GeV |
| $S_T$ | > 0.2 | (0.1,0.3,0.1) |
| $M_T$ | > 100GeV(w lepton) | |

# Discovery Potential (L=1fb$^{-1}$,tanβ=10)




Presented at the last SUSY meeting (21/02) by Kenta.

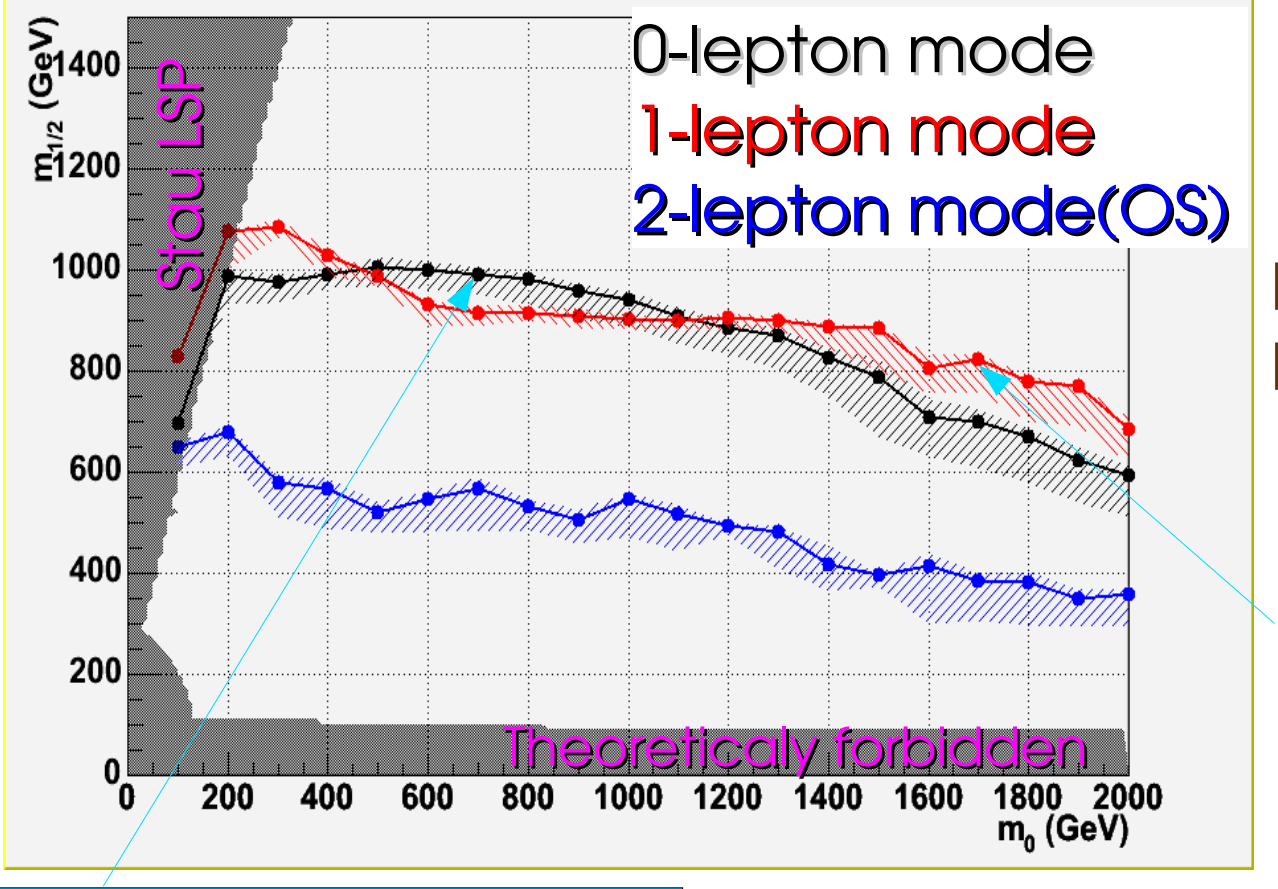
Definition of discovery

S ≥10 && S /√B ≥5

Discovery would be possible up to MSUSY~1.4TeV with the integrated luminosity of 1fb$^{-1}$

# Discovery Potential (L=30fb$^{-1}$,tanβ=10)

## tanβ =10 (L=30fb$^{-1}$)




**Definition of discovery**

S ≥10 && S /√B ≥5

hatched region presents bkg uncertainties

**($m_0$,$m_{1/2}$)=(1700,800)**

m($\tilde{g}$)=1.8TeV

m($\tilde{q}$)=2.3TeV

**($m_0$,$m_{1/2}$)=(700,1000)**

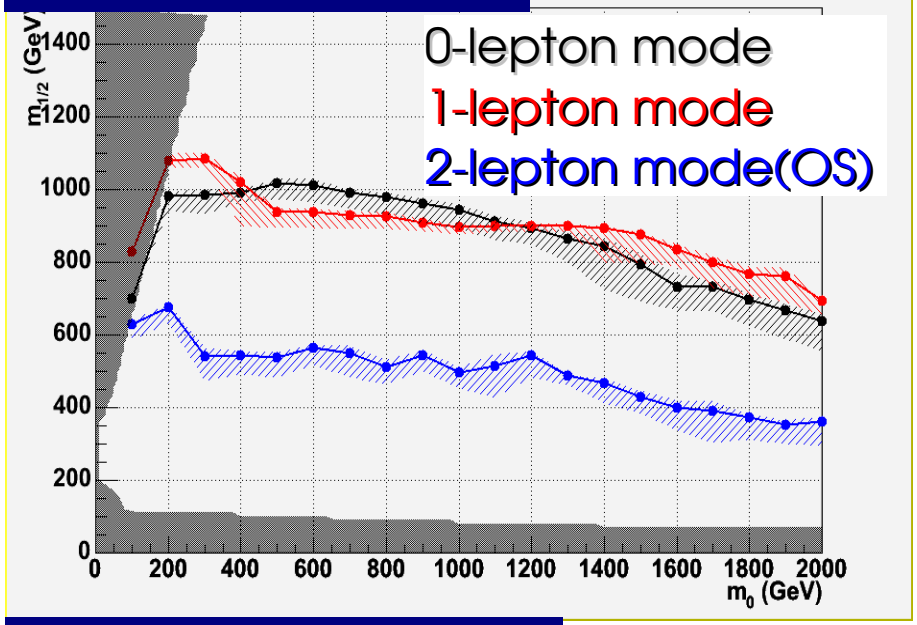
m($\tilde{g}$)=2.2TeV

m($\tilde{q}$)=2.0TeV

1-lepton mode has better sensitivity than 0-lepton mode at small/large m0.

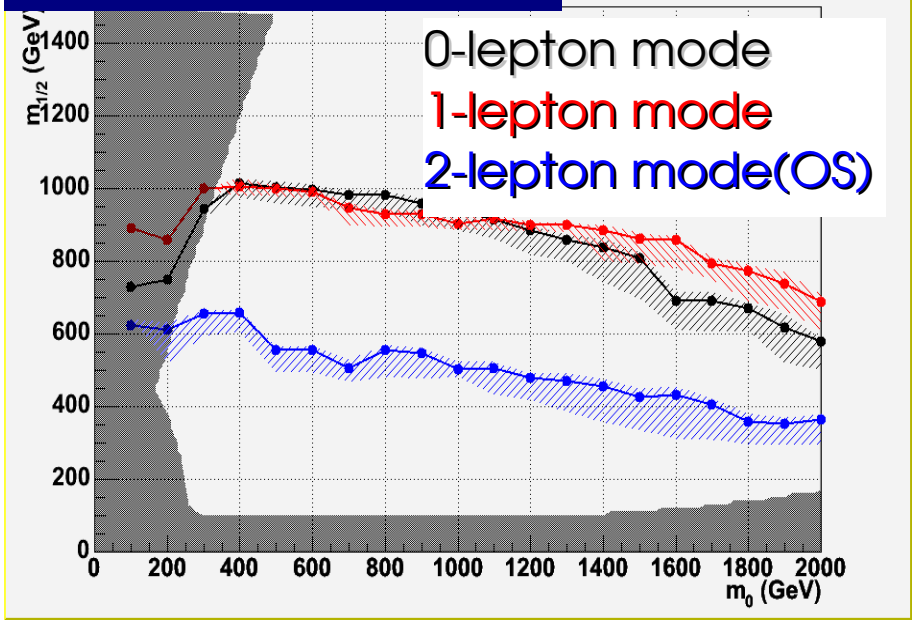
# Discovery Potential (L=30fb$^{-1}$)

## tanβ =5 (L=30fb$^{-1}$)

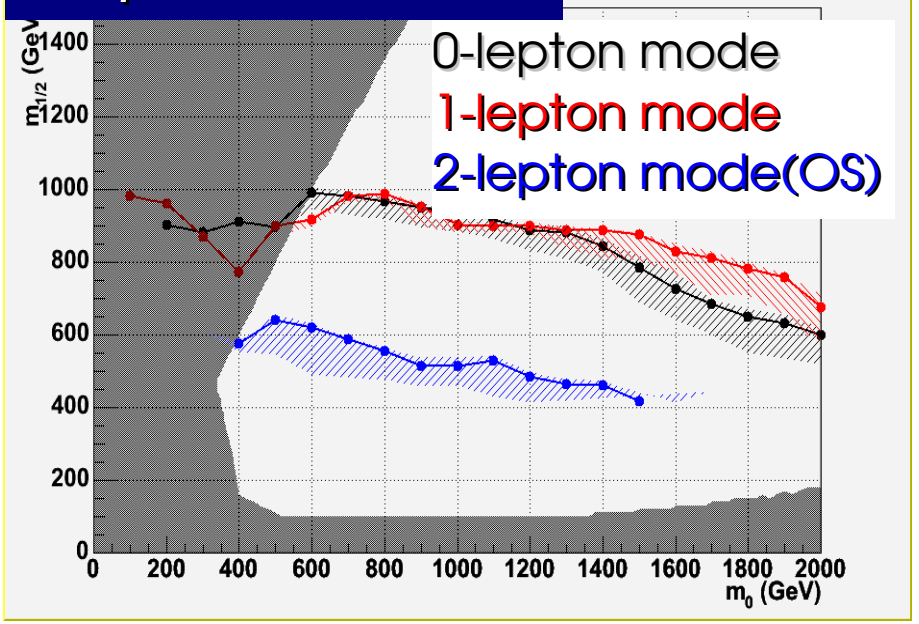



- Less tanβ dependency
- 1-lepton mode slightly better sensitivity than 0-lepton mode at small/large m0

## tanβ =30 (L=30fb$^{-1}$)




## tanβ =50 (L=30fb$^{-1}$)



# Inclusive study of SUSY signature (after discovery)

# Discovery of SUSY-like signature

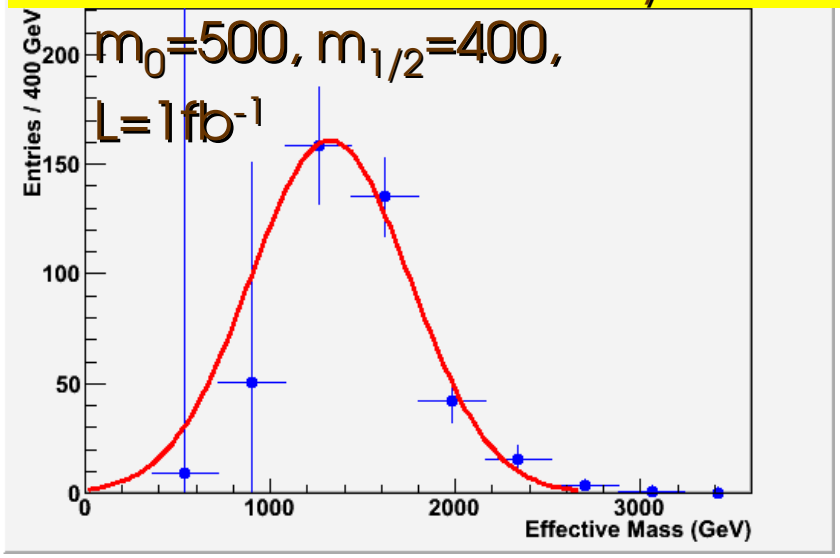
# Once we see excess ...

We start inclusive search of SUSY-like signature by

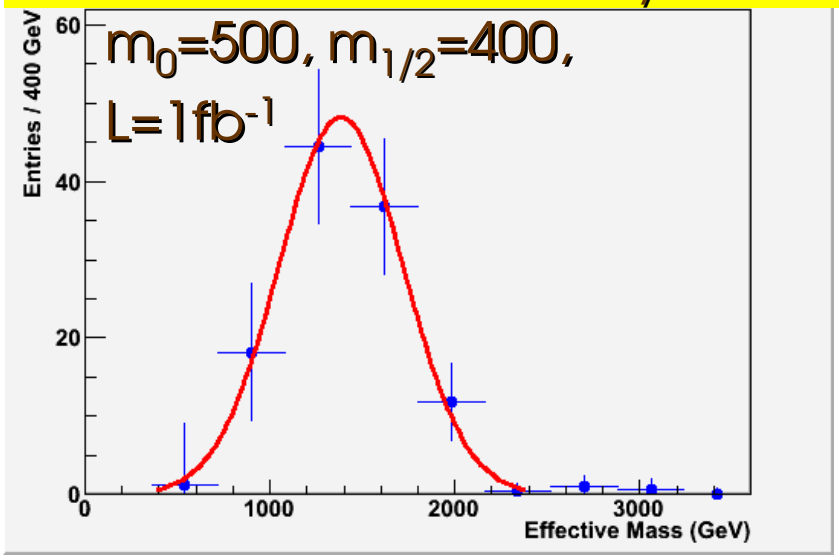
- 0-lepton mode
- 1-lepton mode
- 2-lepton mode (OS/SS)
- di-jet mode ... and more

Hope we can control background with good acuracy and may see excess in some(all?) analyses.

Meff : 0-lepton ($M_{susy}$=1TeV)



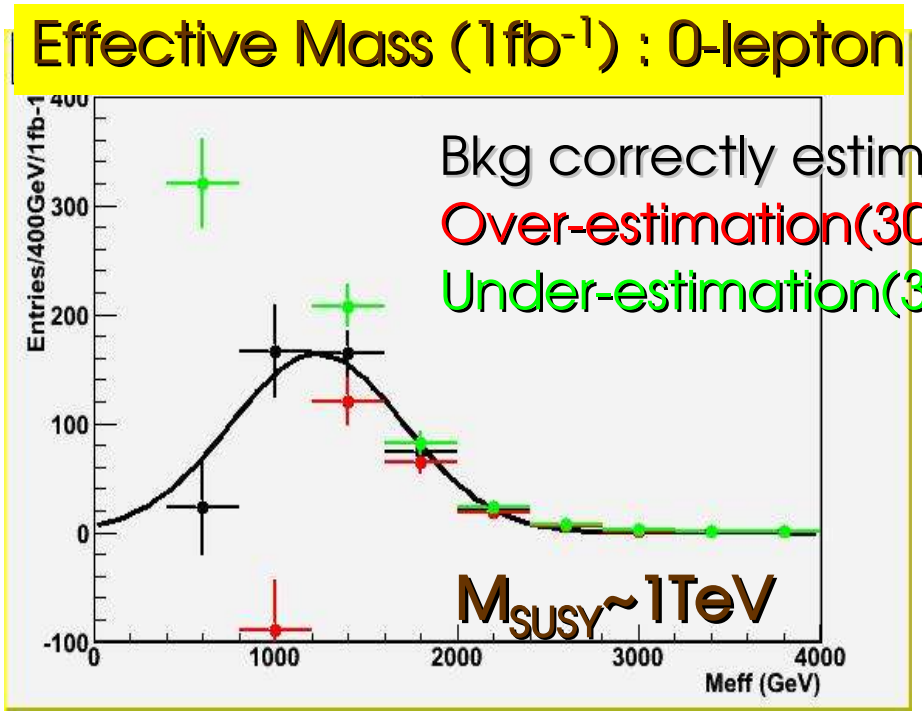

Meff : 1-lepton ($M_{susy}$=1TeV)

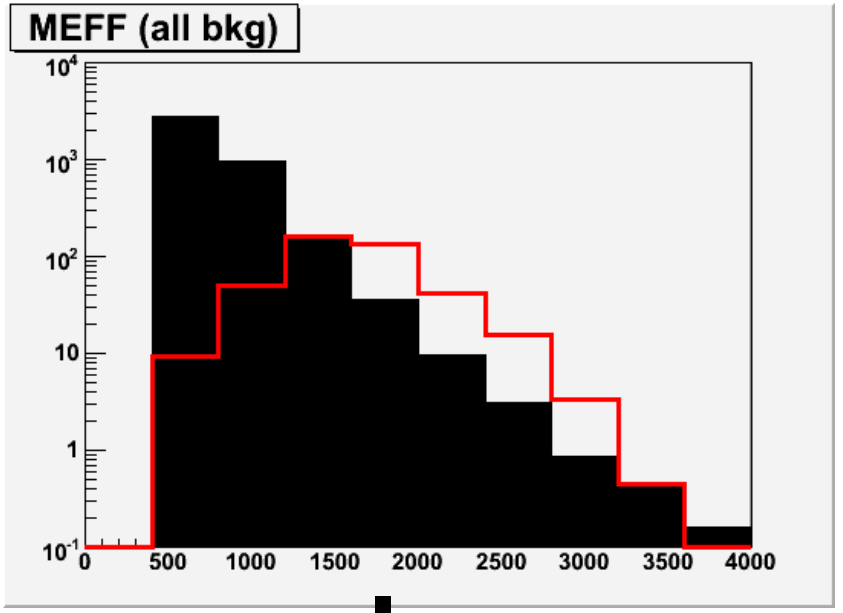


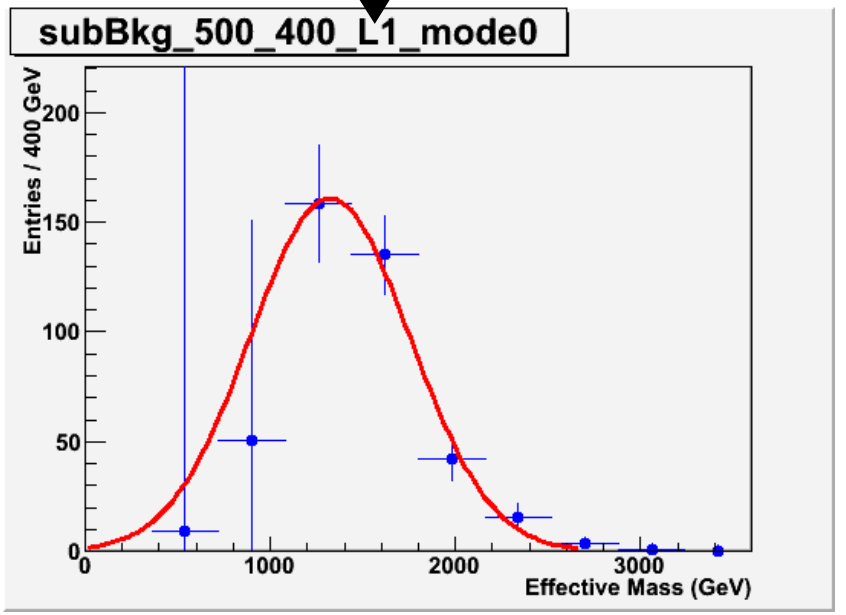

What can we do next?

# Once we see excess … (2)

- Background estimation is crucial to get correct SUSY mass scale.




- Need different cut optimization to know SUSY event topology with less effect from background

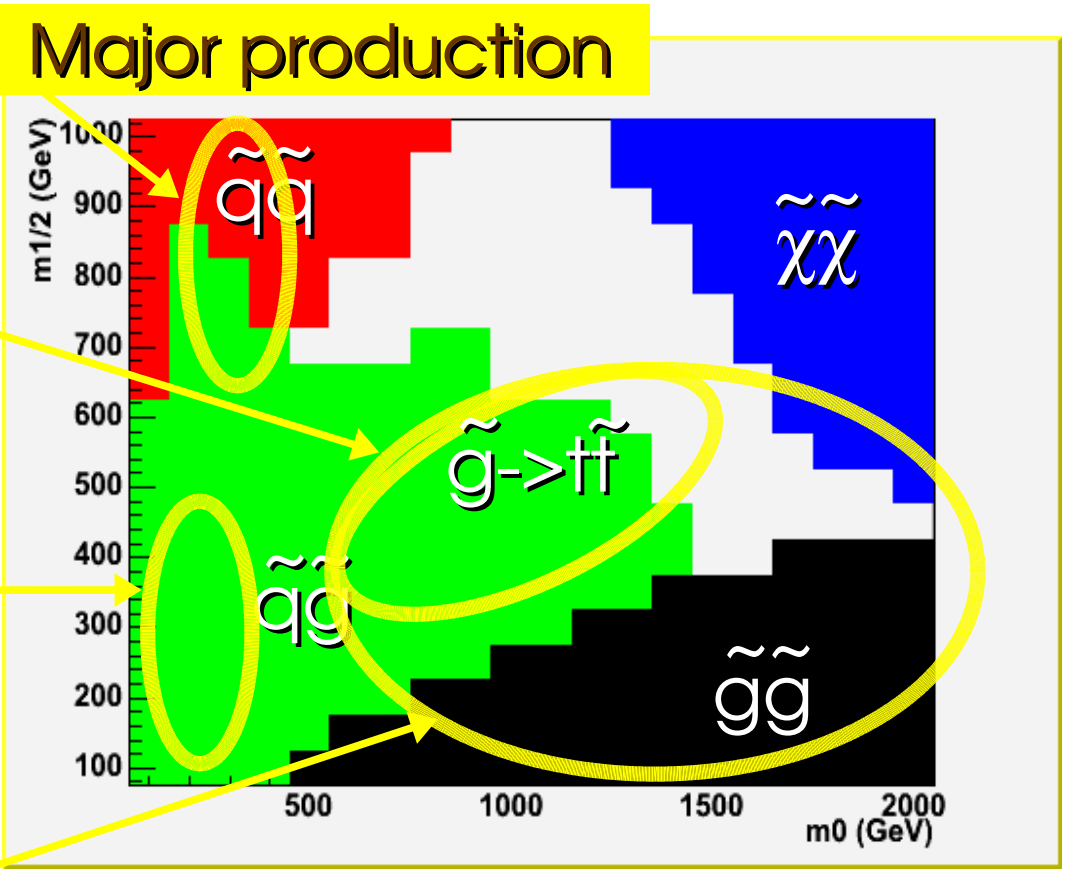
# Inclusive SUSY signature

(A) Light sneutrino/slepton
UPL->W1SS/Z2SS
->SNU+L, SLEP+N/SLEP+L
>> Lepton rich event

(B) Light Stop/Sbottom
GLSS->TP1
->W2SS-> W1SS+Z / Z2SS+W
>> Lepton/b-jet rich event

(C) Directy decay
UPR->Z1SS
>> Lepton poor event

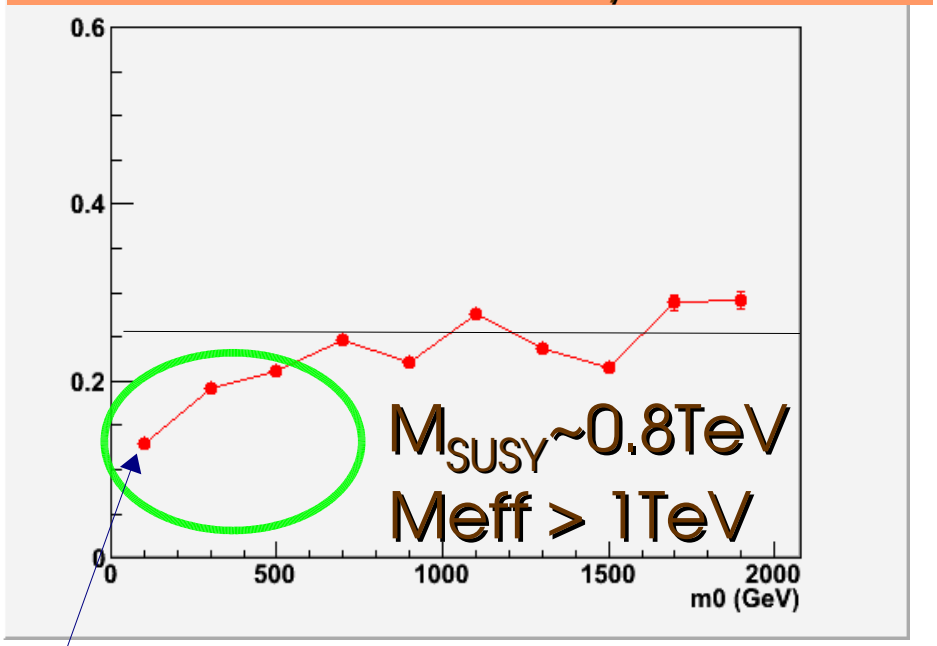
(D) gluino production/decay
GLSS->WnSS/ZnSS + qq
>> Multi-jet like event



# Lepton Richness

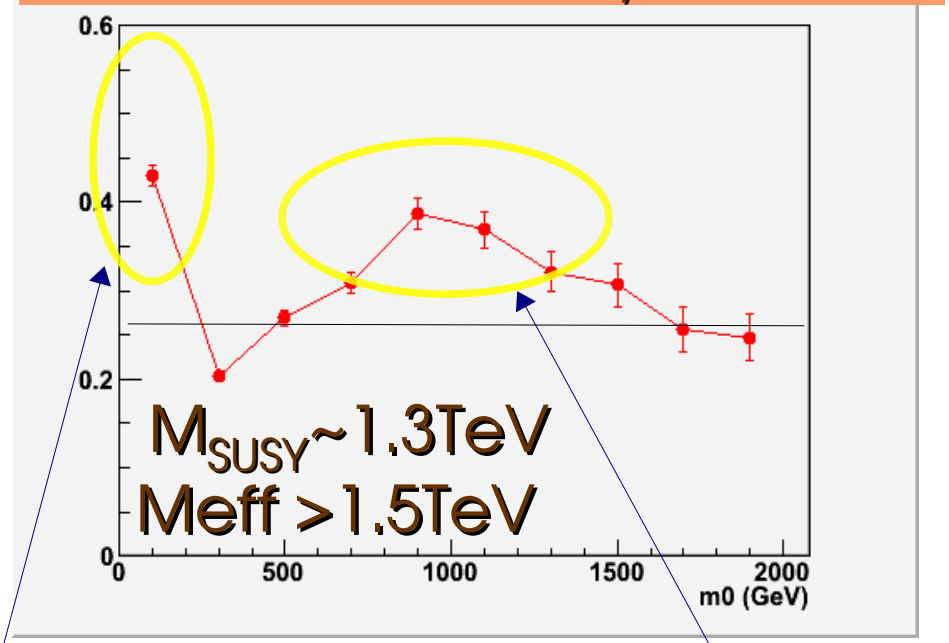
$\langle R_{lep}^{1/0} \rangle$ ( = N(=1)/N(=0) )

$m_{1/2}$=300 GeV($M_{susy}$~0.8TeV)




BR(UPL->W1SS+UP)~64%
BR(W1SS->STAU+NUT)~63%

$m_{1/2}$=500 GeV($M_{susy}$~1.3TeV)




BR(UPL->W1SS+UP)~65%
BR(W1SS->SLEP+L)~38%

BR(GLSS -> ST + T)~95%

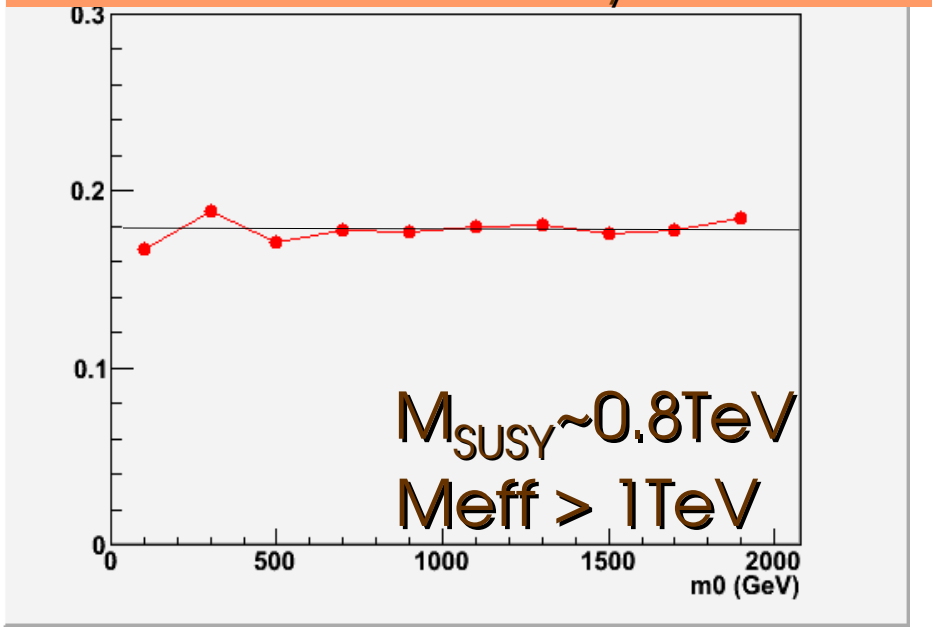
With statistic errors of signal ONLY (L=30$fb^{-1}$)

# b-jet Richness

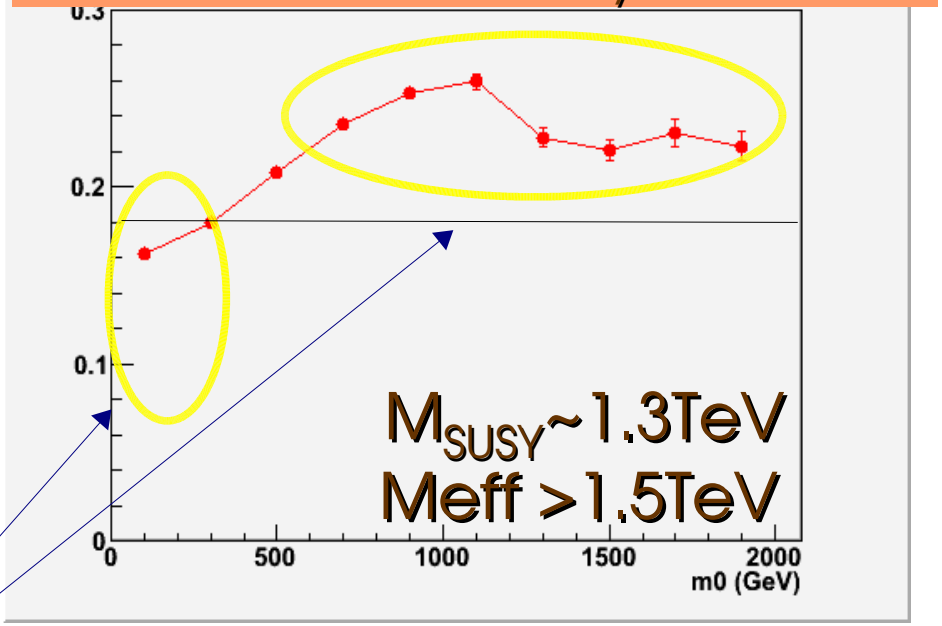
Atlfast btag :
$\varepsilon_b$=60%, $R_c$=10, $R_u$=100

$\langle R_{ptb} \rangle$ ( = $\Sigma |p_T(\text{b-jet})| / \Sigma |p_T(\text{jet})|$ )

$m_{1/2}$=300 GeV($M_{susy}$~0.8TeV)




$m_{1/2}$=500 GeV($M_{susy}$~1.3TeV)



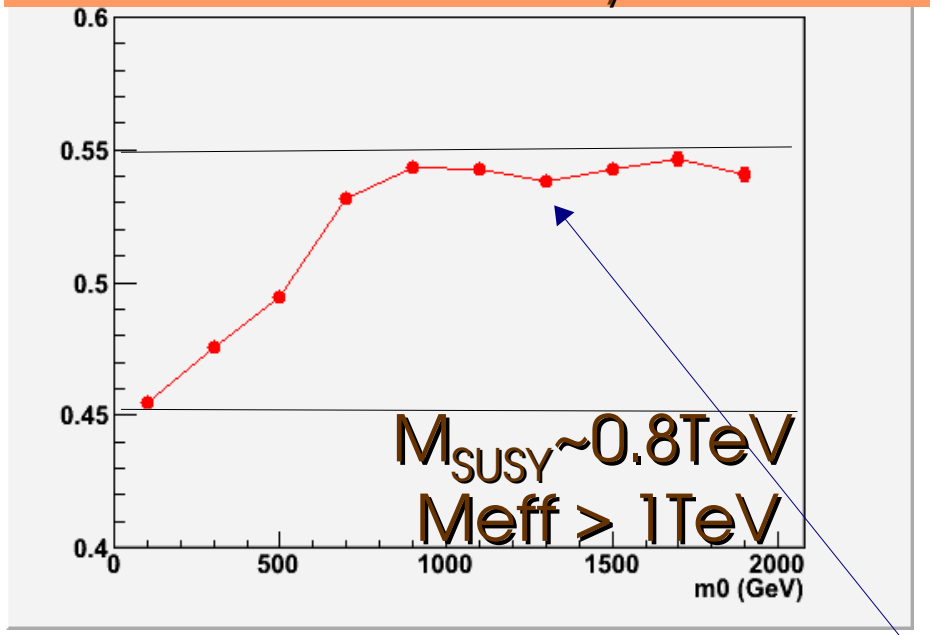

Ambiguity of lepton source is possible be solved with help of b-jet information

With statistic errors of signal ONLY (L=30$fb^{-1}$)

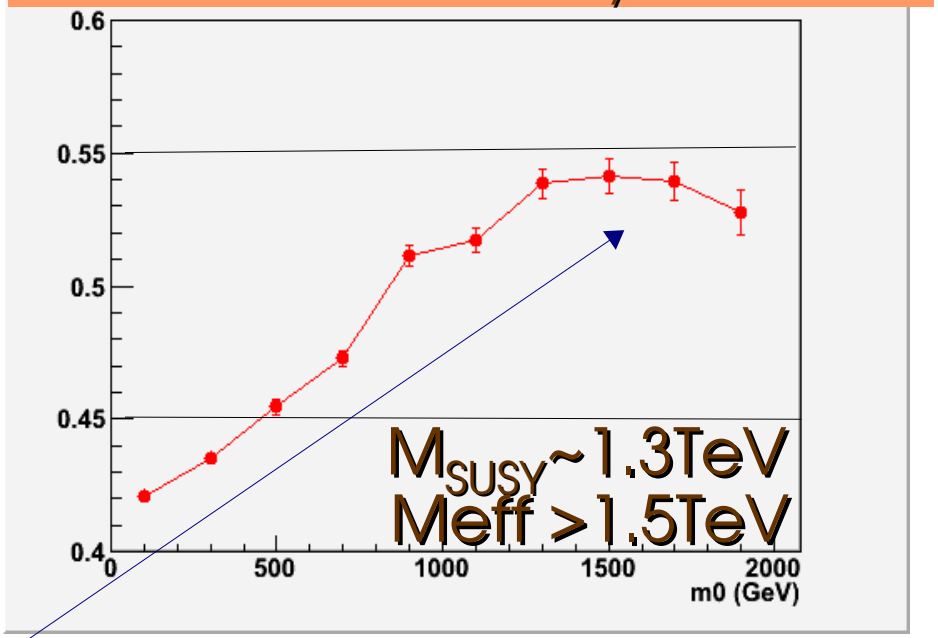
# Multi-jet likeness

<R12> ( = $p_T$(2nd) l / $p_T$(1st) in each hemisphere )

$m_{1/2}$=300 GeV($M_{susy}$~0.8TeV)




$m_{1/2}$=500 GeV($M_{susy}$~1.3TeV)




gluino-gluino production is dominant

With statistic errors of signal ONLY (L=30$fb^{-1}$)

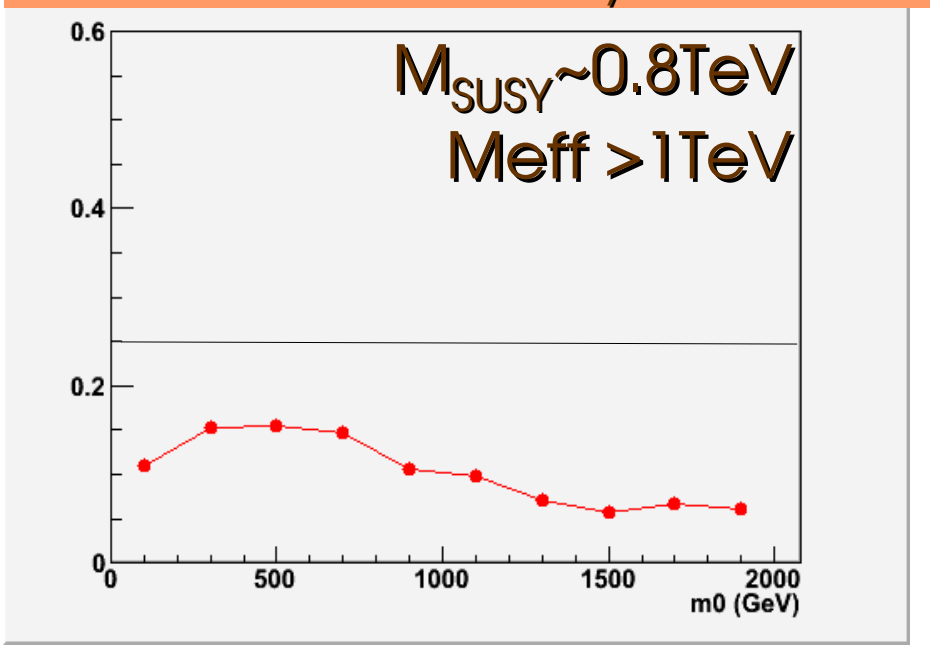
For hemisphere algorithm,
see http://indico.cern.ch/conferenceDisplay.py?confId=7748

# Lepton Richness + background

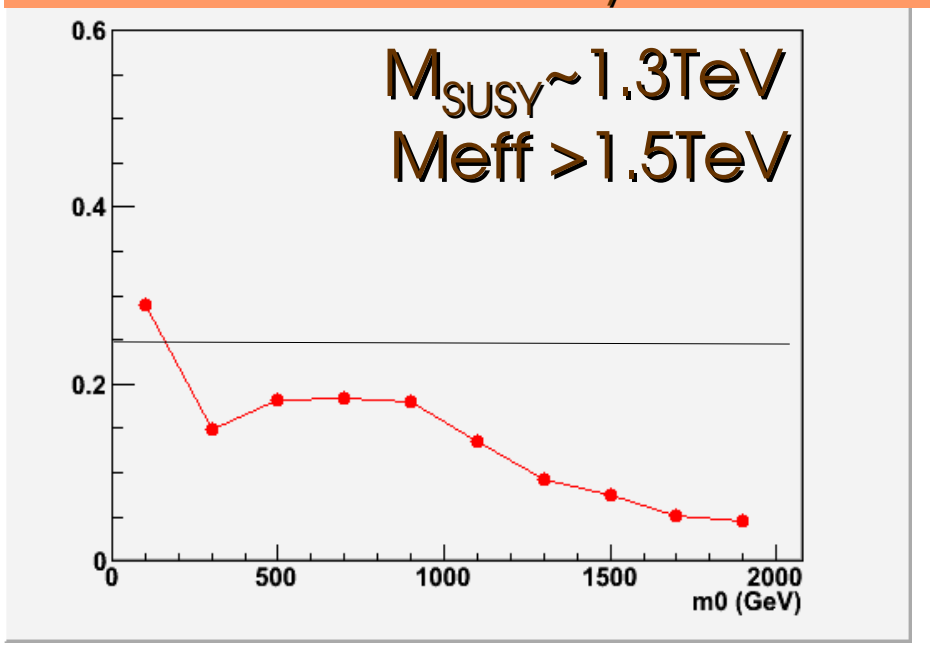
Ofcourse it is not easy in real life due to background...

$\langle R_{lep}^{1/0} \rangle$ ( = N(=1)/N(=0) )

$m_{1/2}$=300 GeV($M_{susy}$~0.8TeV)




$m_{1/2}$=500 GeV($M_{susy}$~1.3TeV)



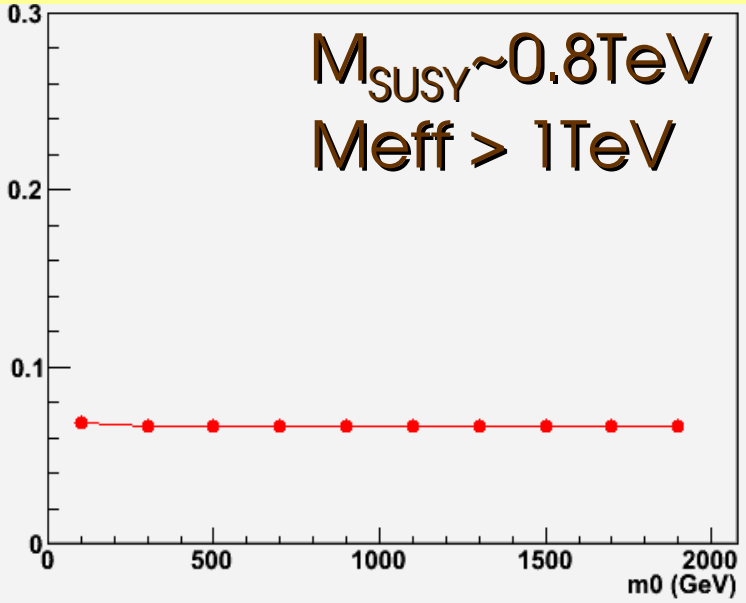

With statistic errors of signal + bkg (L=30fb$^{-1}$) together including systematic uncertainties of bkg estimation

# b-jet Richness , R12 + background...

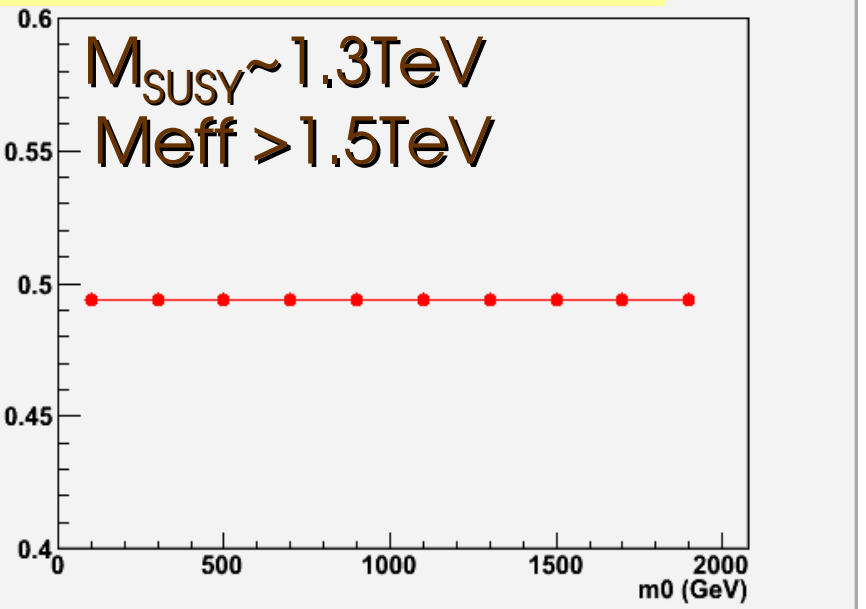
Again... only see event shape of SM background...

$m_{1/2}$=300 GeV($M_{susy}$~0.8TeV)

<Rptb> ( = Σ |$p_T$(b-jet) | / Σ |$p_T$(jet) | )




<R12> ( = $p_T$(2nd) | / $p_T$($1^{st}$) )




With statistic errors of signal + bkg (L=30fb$^{-1}$) together including systematic uncertainties of bkg estimation

# Summary and Outlook

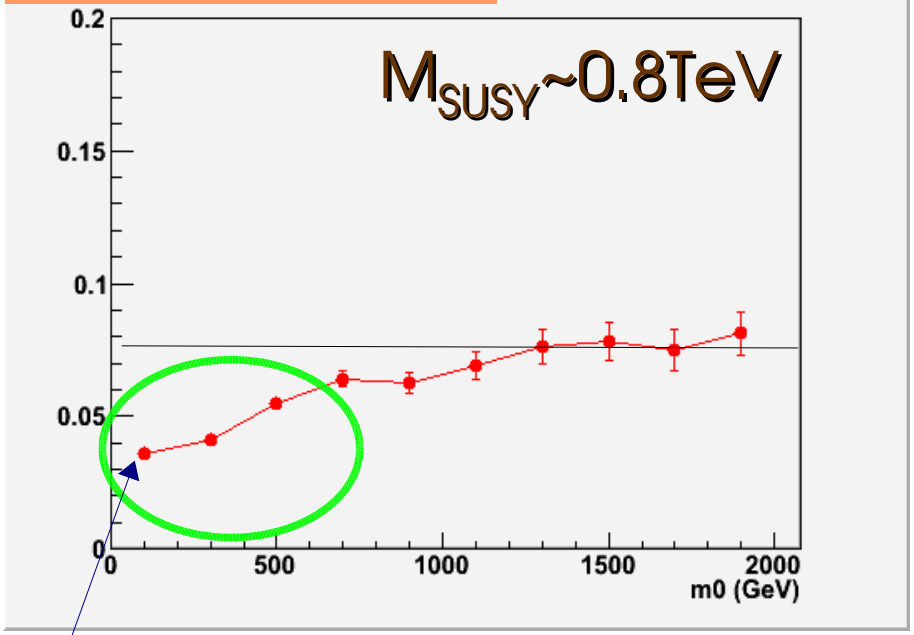
- Study the discovery potential with optimized selections under assumption of mSUGRA
  - Sensitivity does not depend on tanB so much.
  - Discovery potential up to m(g)~2 TeV with the integrated luminosity of 30fb-1.
- Investigate possible study after discovery of SUSY-like signature and before nominal luminosity run
  - lepton/b-jet richness as well as multi-jet likeness would be useful to get hint on production and decay.
  - Removing dilution from background is crucial.
    Try to optimize cut and estimate event variables of SM...

# Backup Slides

# Lepton Richness (3)

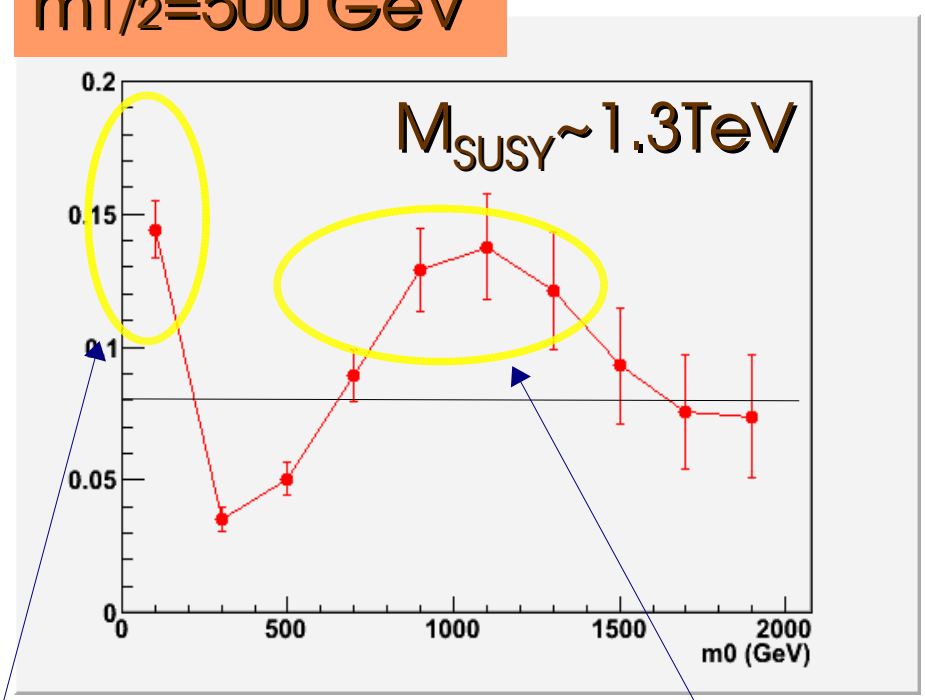
$\langle R_{lep}2^{/0} \rangle$ ( = N(=2)/N(=0) )

$m_{1/2}$=300 GeV




BR(UPL->W1SS+UP)~64%
BR(W1SS->STAU+NUT)~63%

$m_{1/2}$=500 GeV




BR(UPL->W1SS+UP)~65%
BR(W1SS->SLEP+L)~38%

BR(GLSS -> ST + T)~95%

Signal ONLY (L=10fb$^{-1}$) with statistic errors