

# Joint LHC-ILC SUSY Studies

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Snowmass - BSM  
Phone Meeting  
April 22, 2013  
J.List, DESY

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# Overview

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## 1) Joint study of a full MSSM point

- LHC (CMS): Isabelle Melzer-Pellmann,  
Altan Cakir,  
Artur Lobanov (all DESY)
- ILC (ILD): Mikael Berggren, JL (DESY)

=> will report today mainly on this one

## 2) Simplified Model scan of electroweakino sector

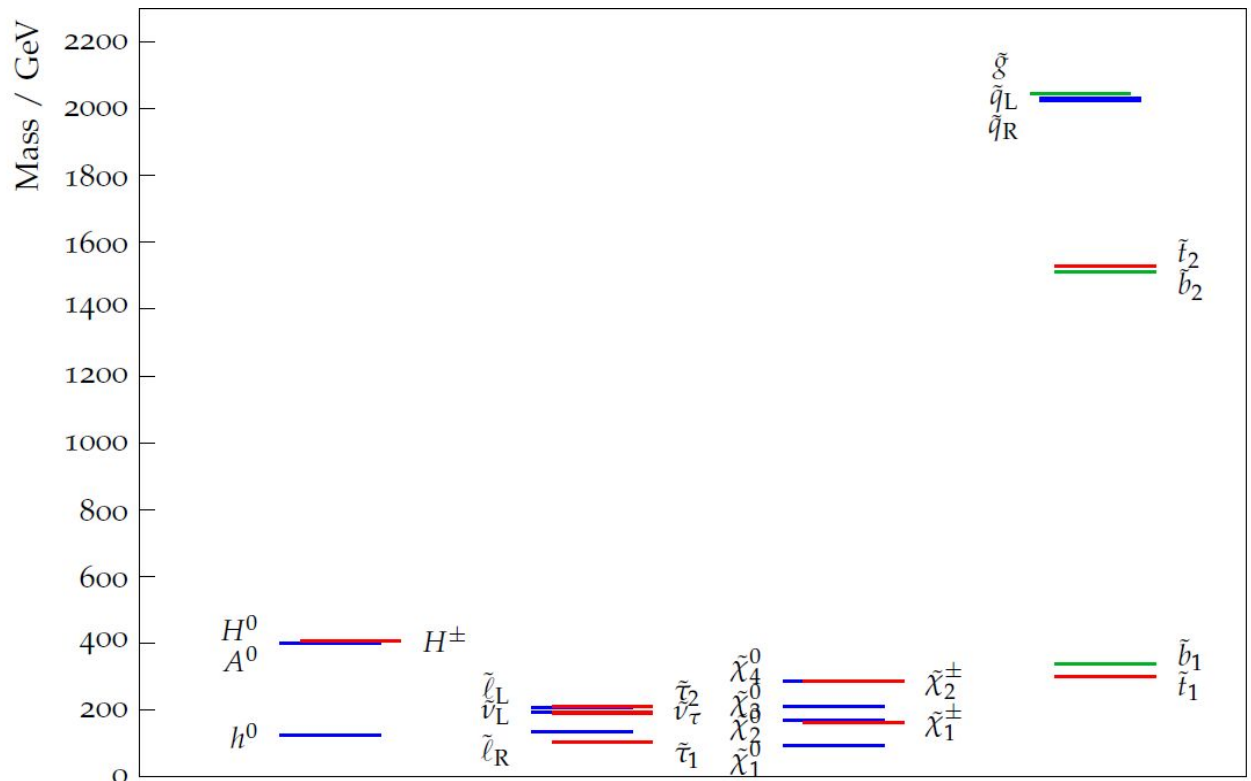
- LHC (CMS): Sanjay Padhi (UC Riverside)
- ILC (ILD): Tomohiko Tanabe, (Tokyo University)  
Mikael Berggren, JL (DESY)



# Study of a Full MSSM Point

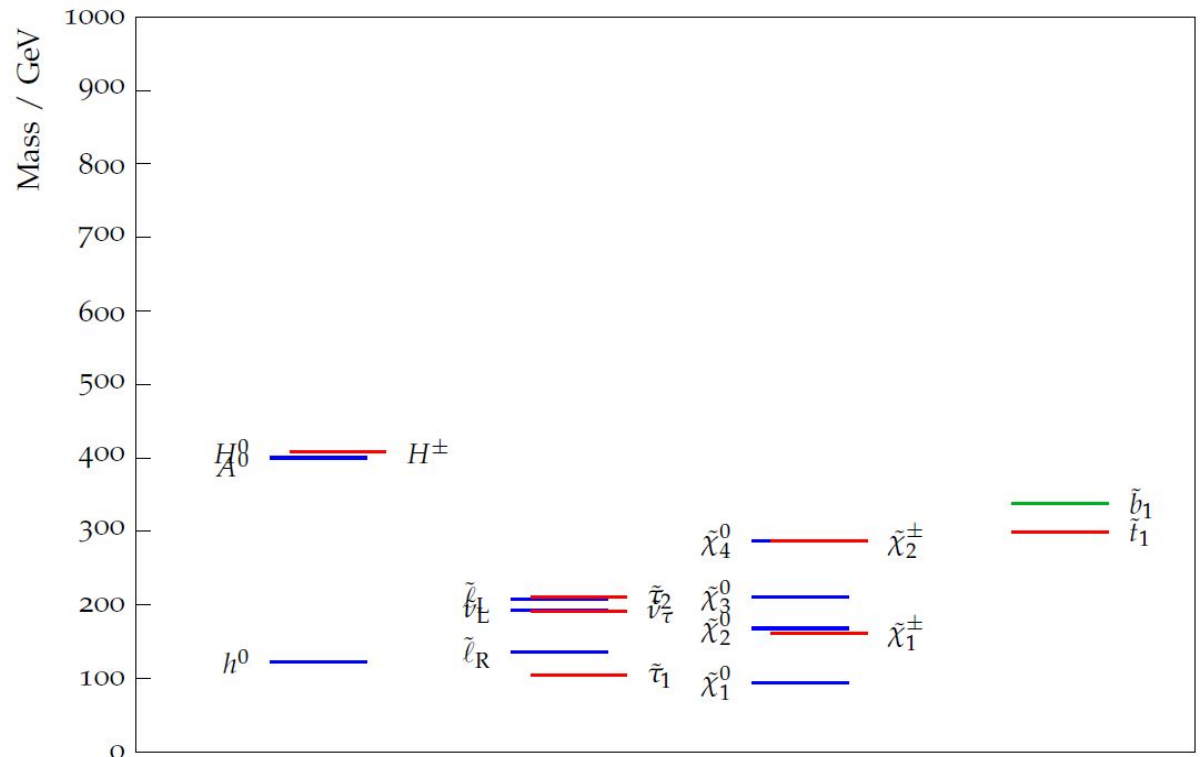
# Spectrum

- select point with rich phenomenology for both machines
- tell "story" about complementarity, eg. LHC discovers colored states, but need ILC to resolve all details of ew part of spectrum
- can use point for which some studies exist already?
- first try: a stau-coannihilation scenario



# Spectrum - Zoom below 1 TeV

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# LHC part of the study [Lobanov, Cakir, Melzer-Pellmann]

- First step: cross-sections and dominating production modes from Pythia8

	7 TeV	8 TeV	13 TeV	14 TeV
Total SUSY x-section	2.2 pb	3.2 pb	10.8 pb	13.2 pb
Thereof gg->st1 st1	24%	28%	39%	40%
qq->X+2 X+-1	18 %	16%	10%	10%
ff->X+1 X+-1	11 %	10%	6%	6%
gg->sb1 sb1	11%	13%	20%	21%
ff-> st1 st1	6%	6%	6%	5%

- stop pair production dominating
- light squark / gluino production negligible even at 14 TeV

# LHC part of the study [Lobanov, Cakir, Melzer-Pellmann]

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- Stop properties:
  - $M = 298.7 \text{ GeV}$
  - Dominant decay mode:  $\text{BR}(\text{st1} \rightarrow X^{\pm 1} b) = 92.6\%$
  - Followed by  $\text{BR}(X^{\pm 1} \rightarrow \text{stau1 } \nu_{\tau}) = 97.1\%$   
 $M(X^{\pm 1}) = 161.6 \text{ GeV}$
  - Followed by  $\text{BR}(\text{stau1} \rightarrow \tau + \text{LSP}) = 100\%$ ,  
 $\Delta M(\text{stau-LSP}) = 10 \text{ GeV}$

=> first try: check sensitivity of analysis CMS-SUS-11-006  
(b-jets + MET, so far 5fb<sup>-1</sup> of 7 TeV data)

# LHC part of the study [Lobanov, Cakir, Melzer-Pellmann]

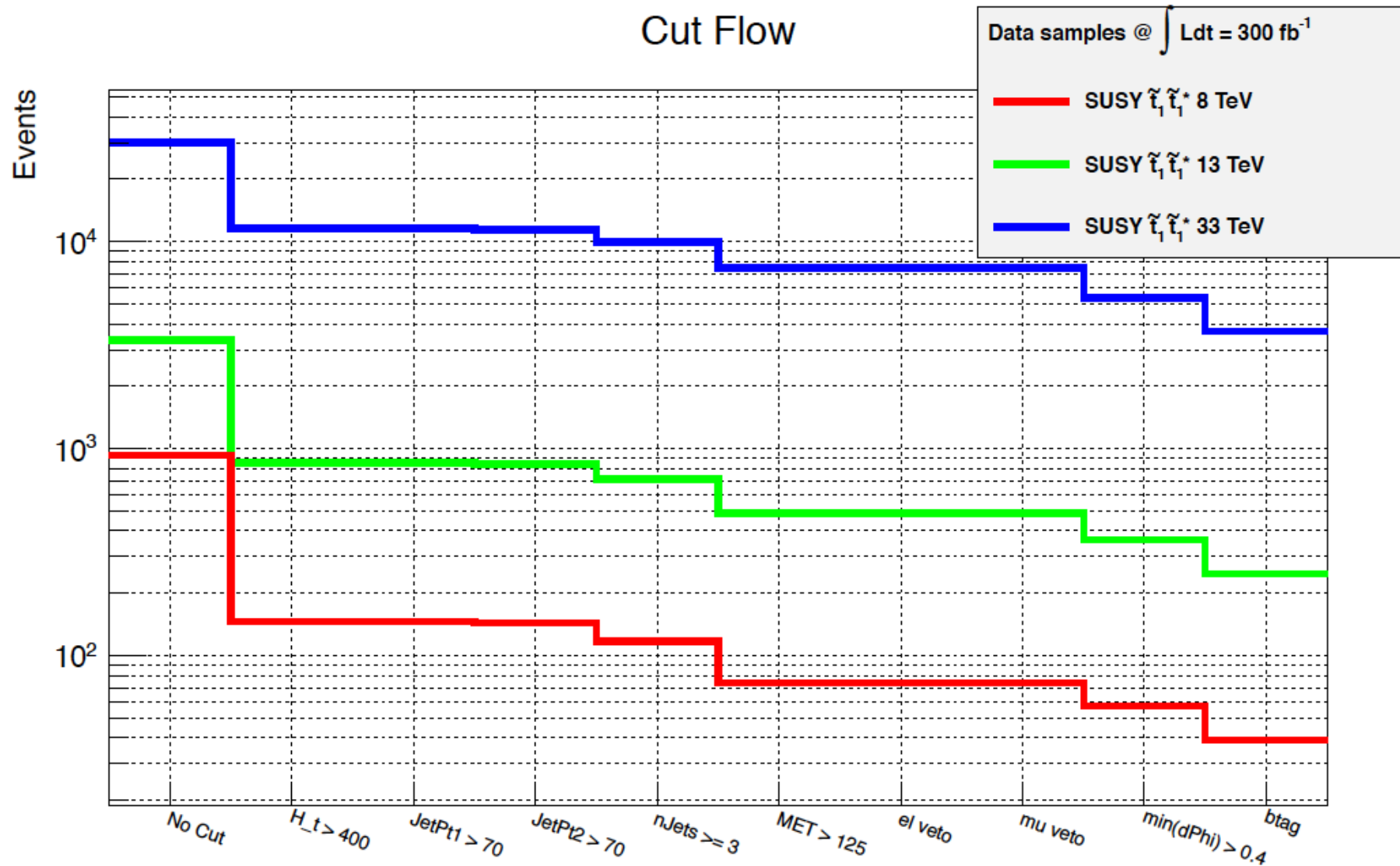
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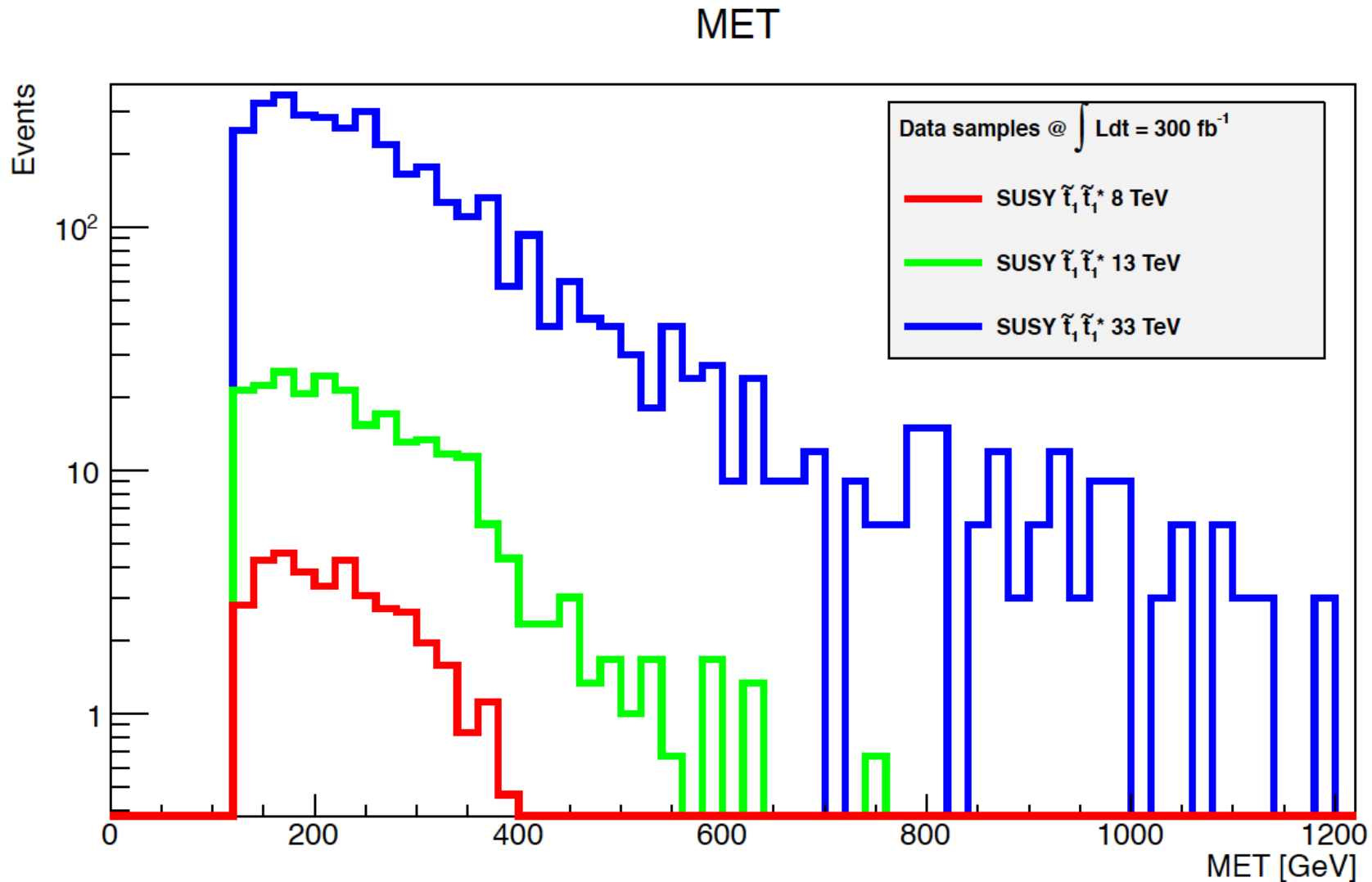
- Run 10k SUSY events (all processes mixed) through Delphes emulation of b-jets + MET analysis (visible part of chargino decay chain too soft → chargino = MET)
- No SM backgrounds yet
- No Pile-Up yet
- Assume luminosity of 300 fb<sup>-1</sup> for 8, 13, 33 TeV each
- Following pages: cutflow, MET, HT



# LHC part of the study [Lobanov, Cakir, Melzer-Pellmann]

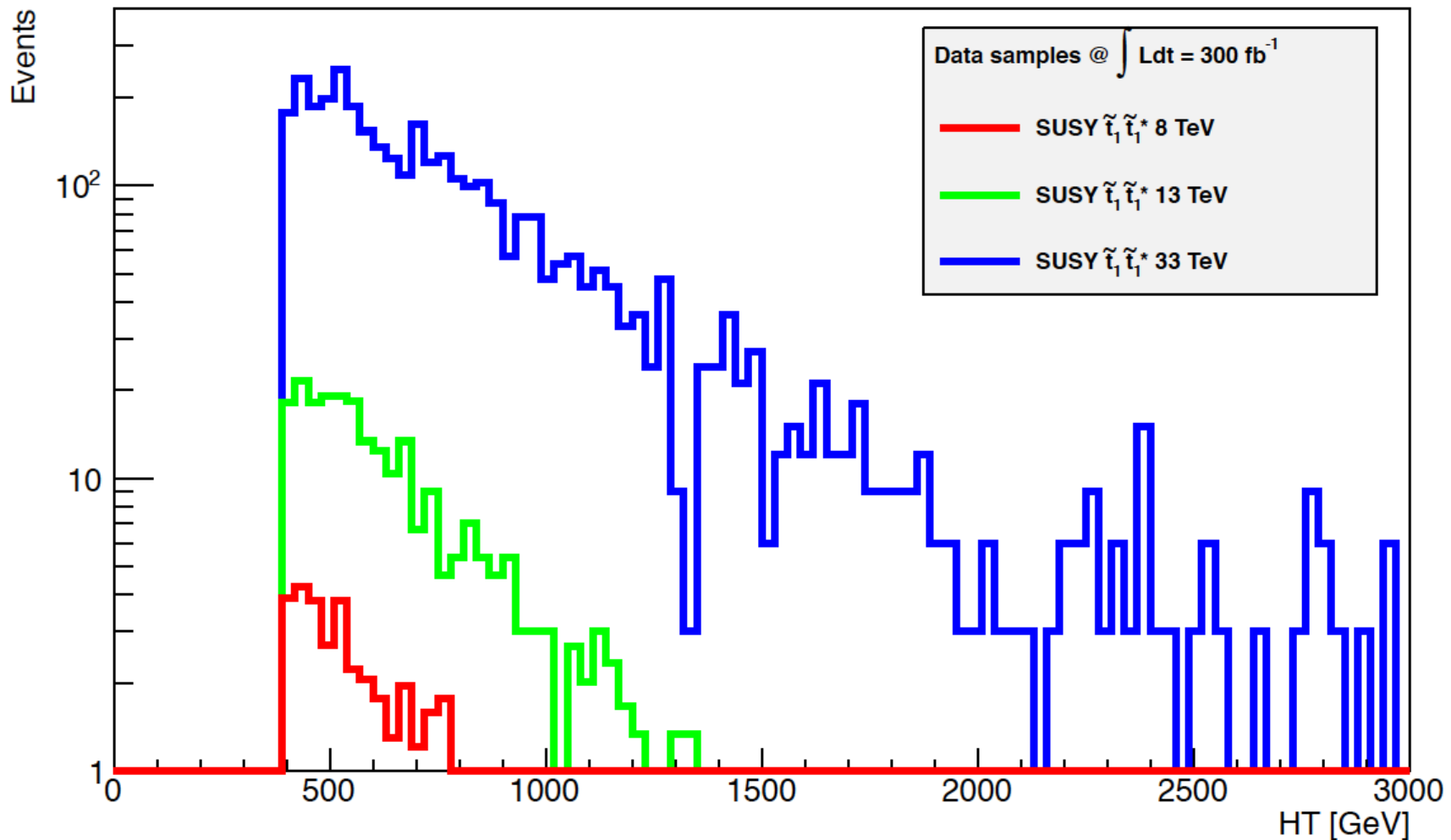


# LHC part of the study [Lobanov, Cakir, Melzer-Pellmann]



# LHC part of the study [Lobanov, Cakir, Melzer-Pellmann]

HT



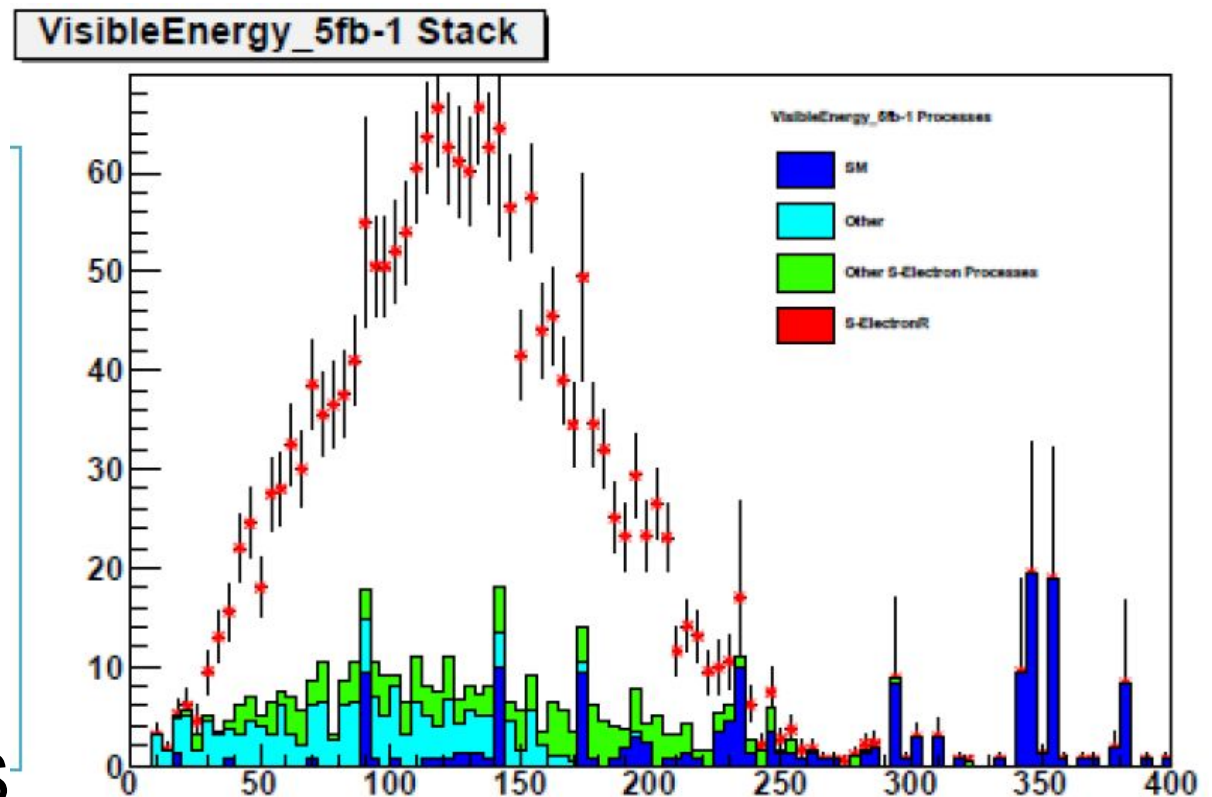
# LHC part of the study [Lobanov, Cakir, Melzer-Pellmann]

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- Conclusion sofar:
  - Suggested point not excluded sofar even with 8 TeV data (note: previous plots for 300fb<sup>-1</sup>!)
  - Accessible at 13 TeV (esp with 3000fb<sup>-1</sup>)
- Plans:
  - **WAITING for Delphes root files for SM background!**
  - Include pile-up
  - Check possibility of dedeciated analysis
  - Check more channels / analyses

# ILC Part of the Study [Berggren, JL]

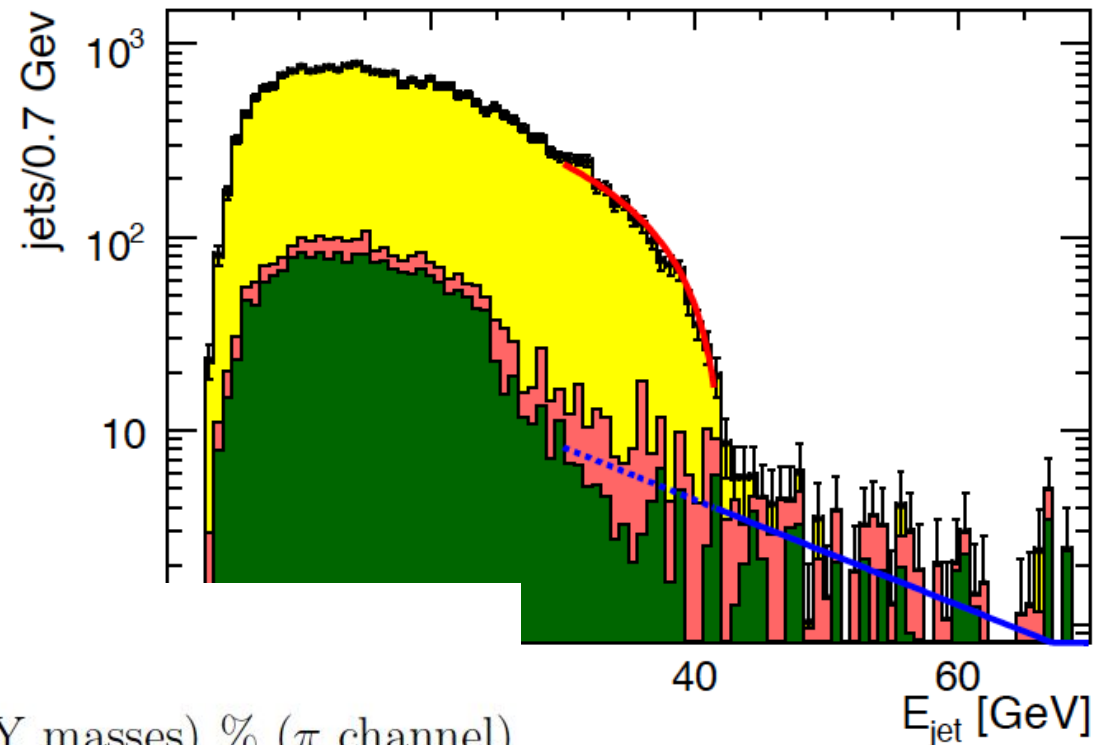
- Rule of thumb:  
all sparticles with  $M < ECM/2$  accessible
- Largest cross-section:  
selectron\_right pair production  
( $M = 135$  GeV)
- Jumps into your face in a few days
- Plot: 5fb-1  
incl all SM and SUS backgrounds



# ILC Part of the Study [Berggren, JL]

- Published study applicable to this scenario:  
<http://arxiv.org/abs/arXiv:0908.0876>

- Stau sector, eg.  
Stau1 pair  
production:  
yellow: signal  
green: SM  
red: SUSY BKG



$$\frac{\delta\sigma}{\sigma} = 3.1 \%$$

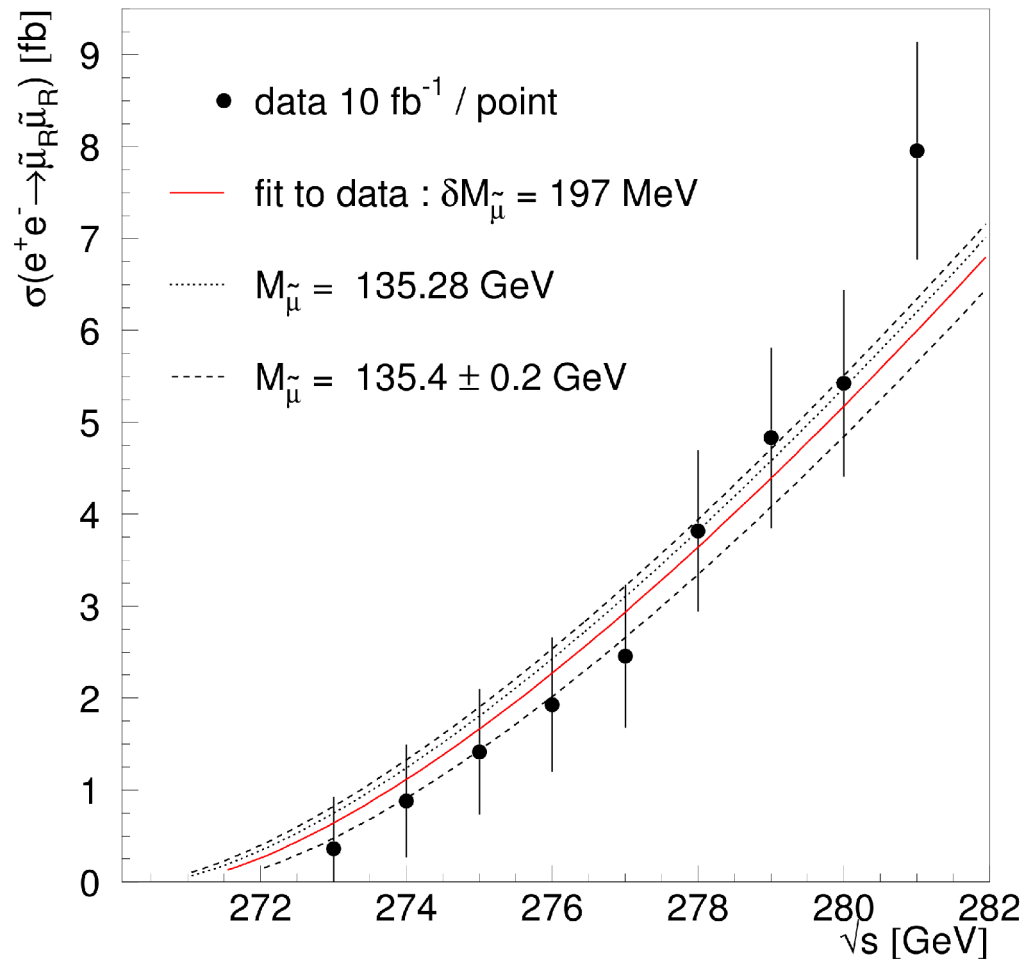
$$\mathcal{P}_\tau = 91 \pm 6 \pm 5 \text{ (bkg)} \pm 3 \text{ (SUSY masses)} \% \text{ (}\pi \text{ channel)}$$

$$\mathcal{P}_\tau = 86 \pm 5 \% \text{ (}\rho \text{ channel)}$$

$$M_{\tilde{\tau}_1} = 107.73_{-0.05}^{+0.03} \pm 1.1 \cdot \delta M_{\tilde{\chi}_1^0} \text{ GeV (endpoint).}$$

# ILC Part of the Study [Berggren, JL]

- From ILC



# ILC Part of the Study [Berggren, JL]

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- More channels to come:
- Smuon continuum
- Gauginos
- Heavier sleptons
- Stop
- Sbottom
- SUSY Higgses