Theory: Direct EWK-ino

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The Foundation for The Gator Nation

Based on: work done in the last century
or
yesterday's talks

LHC physics workshop
Chicago, May 4, 2012

Outline

- What is an EWK-ino?
- What are the current limits on EWK-inos?
- Why hasn't the LHC found them yet?
- How do you search for EWK-inos directly?
- Why are (final states with) taus important?
- How "model-independent" are the EWK-ino bounds in terms of simplified models?
- How can theorists reinterpret EWK-ino searches at the LHC?

What is EWK-ino?

- EWK-ino = Neutralino, other light stuff.
- For the purposes of this talk:
  - basically the charginos and neutralinos in SUSY.
  - but do not include the LSP (Bino or gravitino)
    - direct DM production needs an ISR tag: monojet signature

Birkedal,KM,Perelstein; Beltran,Hooper,Kolb,Krusberg,Tait; Bai,Fox,Harnik

12:00 Lunch (1h0')

MET (12:35 ->15:35)

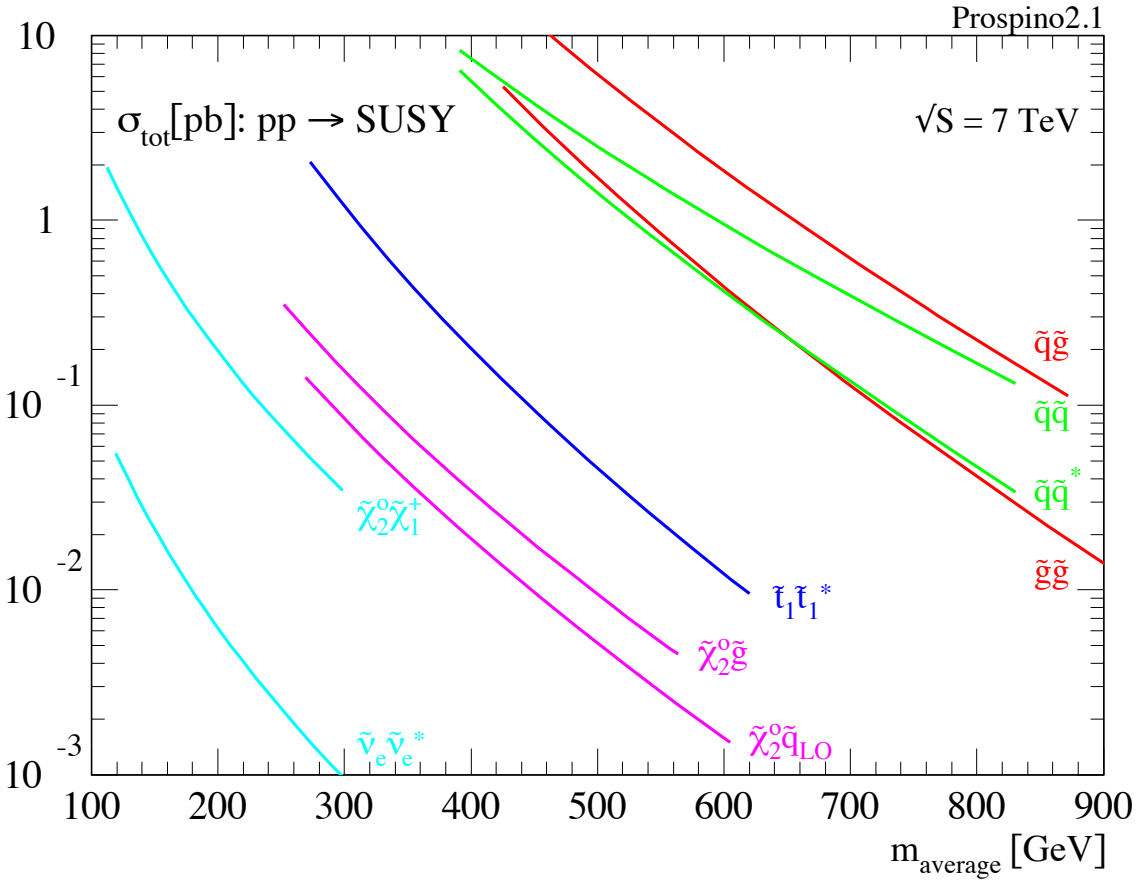
Chairperson: Joe Lykken, Rick Cavanaugh (University of Illinois at Chicago (US))

Location: 300

13:00 **38.**	**Experiment: Light stops** (20')	Ximo Poveda Torres (Physics Department)
13:20 **39.**	**Theory: Light stops** (20')	Stephen Martin (Northern Illinois University)
13:40 **40.**	**Experiment: Direct EWK-ino** (20')	Sanjay Padhi (Department of Physics)
14:00 **41.**	**Theory: Direct neutralino, other light stuff** (20')	Konstantin Matchev (University of Florida (US))
14:20 **42.**	**Experiment: Presentation of scientific results** (20')	Maurizio Pierini (CERN)
14:40 **43.**	**Theory: Presentation of scientific results** (20')	Scott David Thomas (Rutgers, State Univ. of New Jersey (US))

Gluinos and squarks are the low hanging fruit

- Colored superpartners have larger cross-sections



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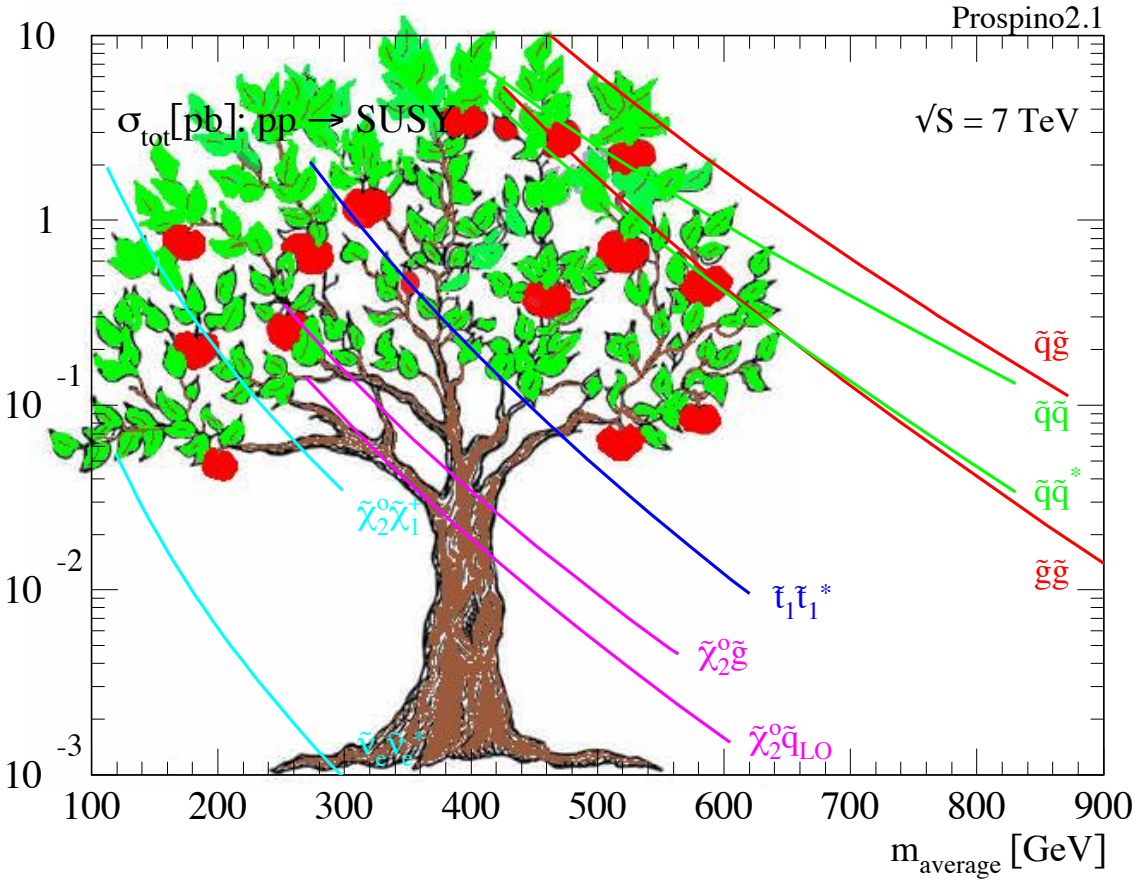

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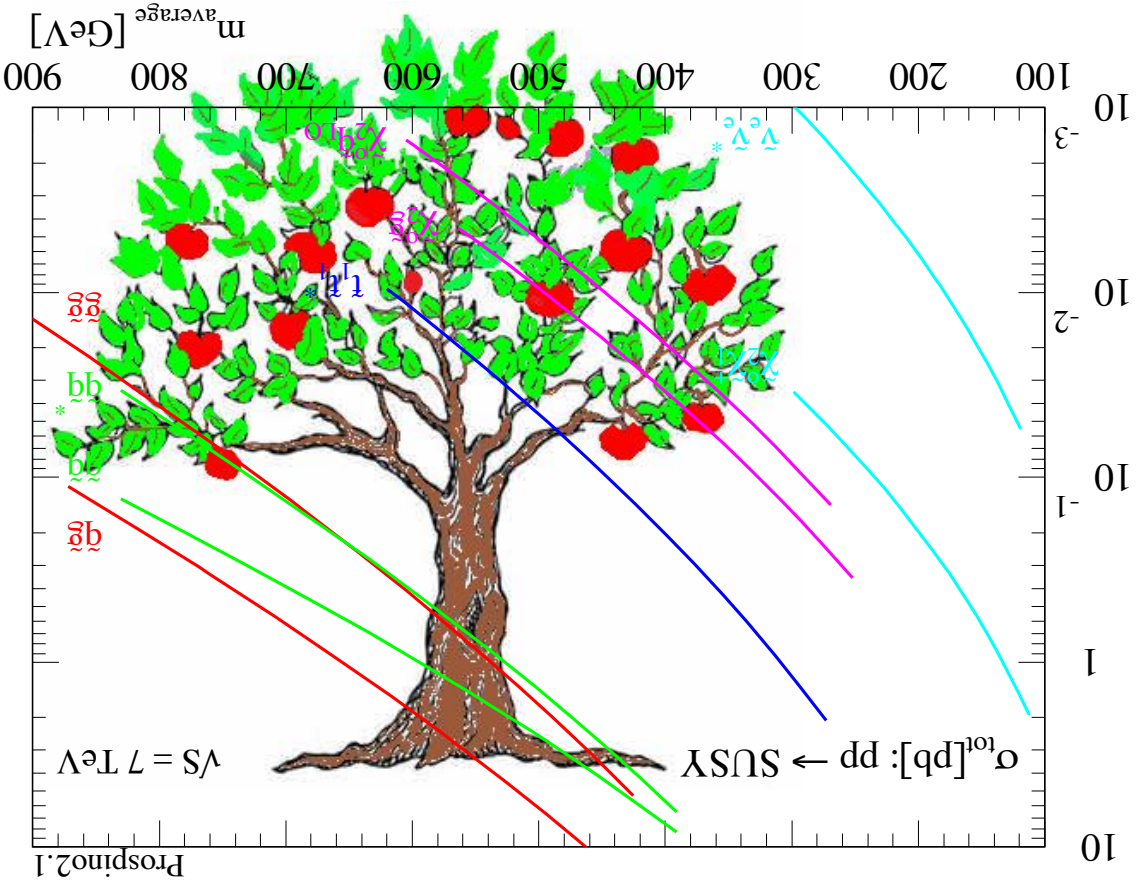
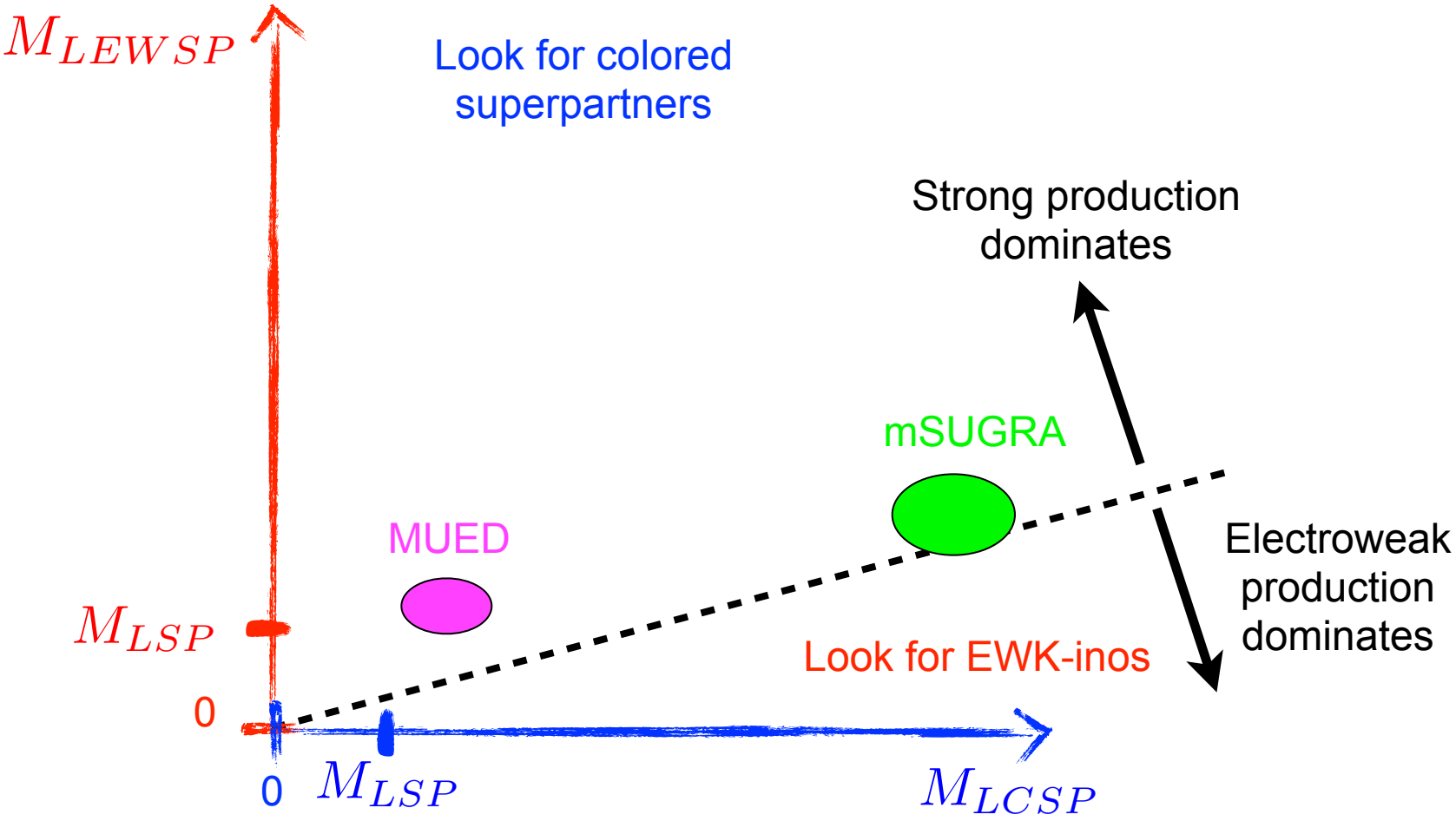


What signatures to look for?

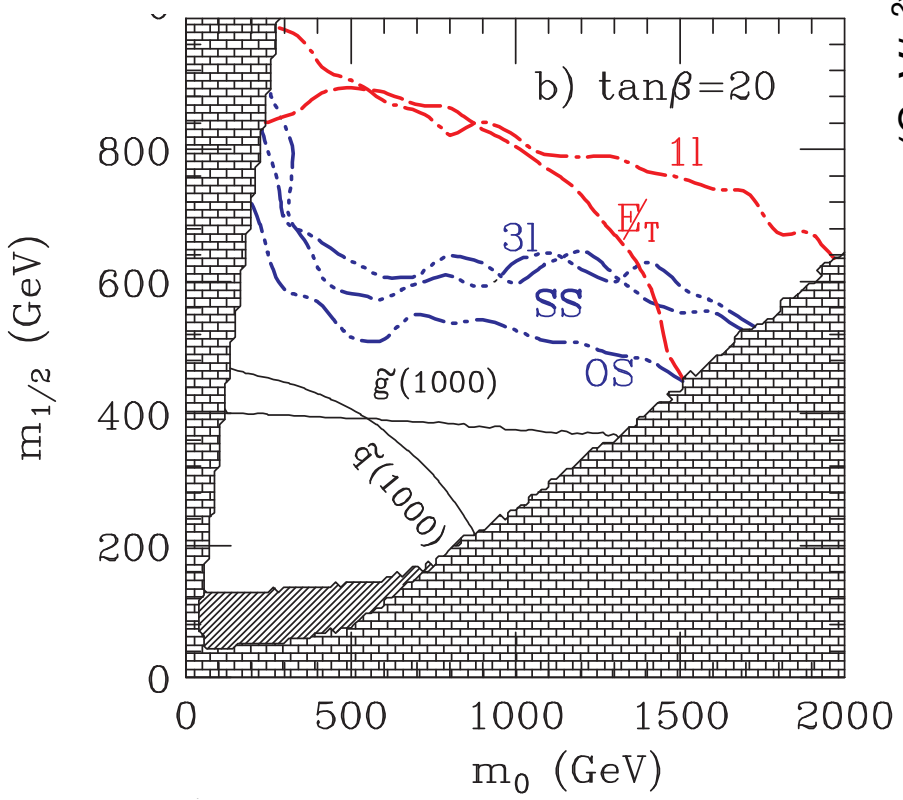


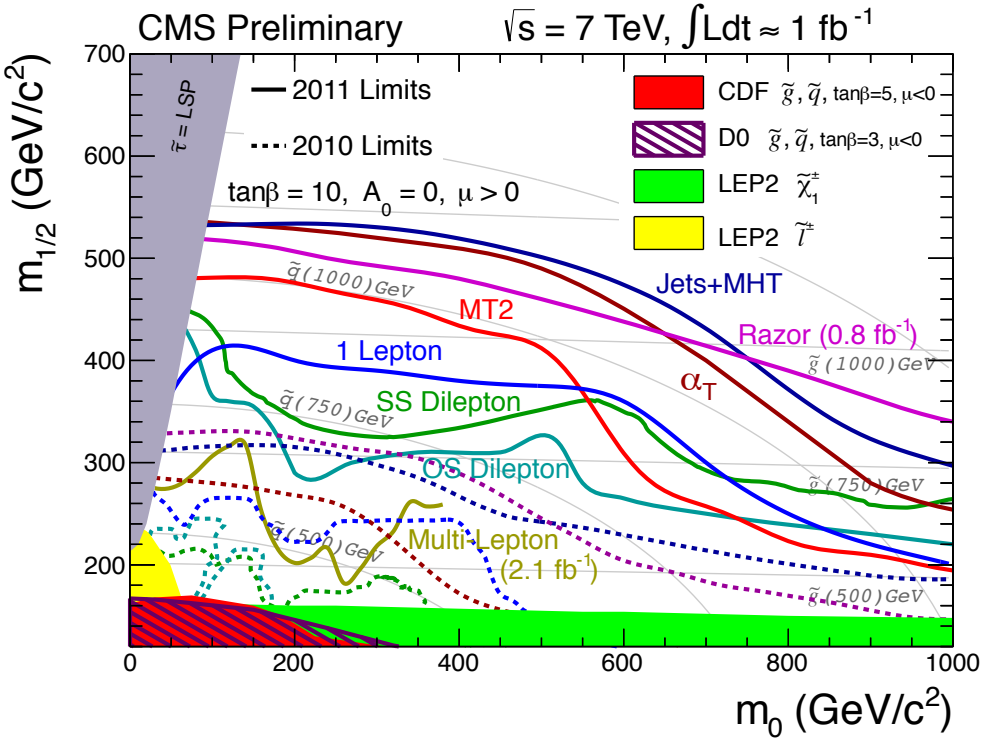
See Danielle's talk yesterday

20-th century expectations

- Jetty channels always showed better reach
- Lepton channels were considered more reliable

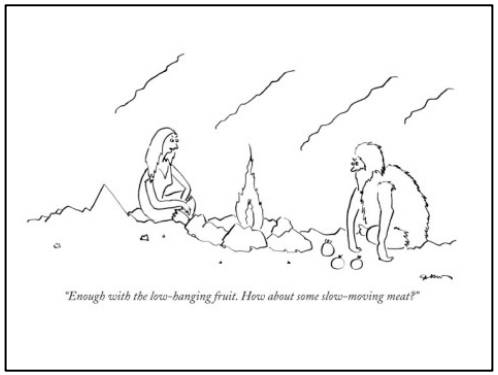
Baer,Chen,Drees,Paige,Tata (1998)

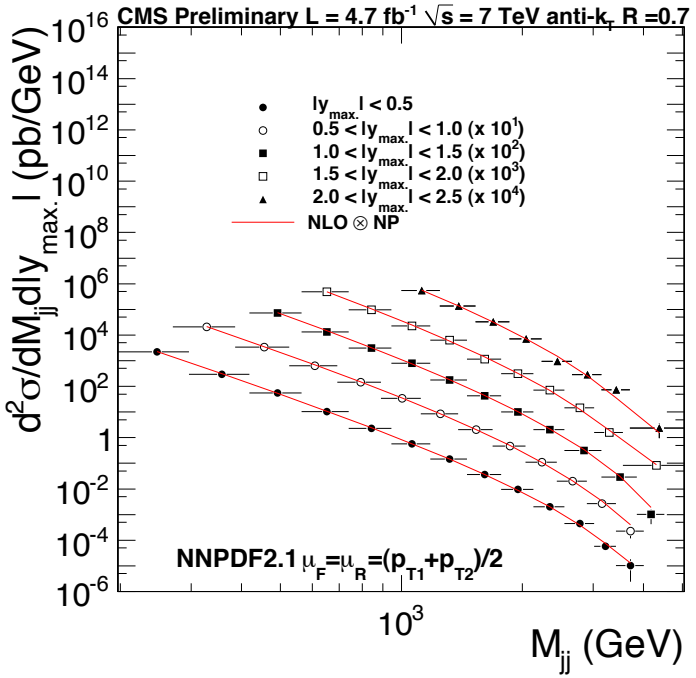


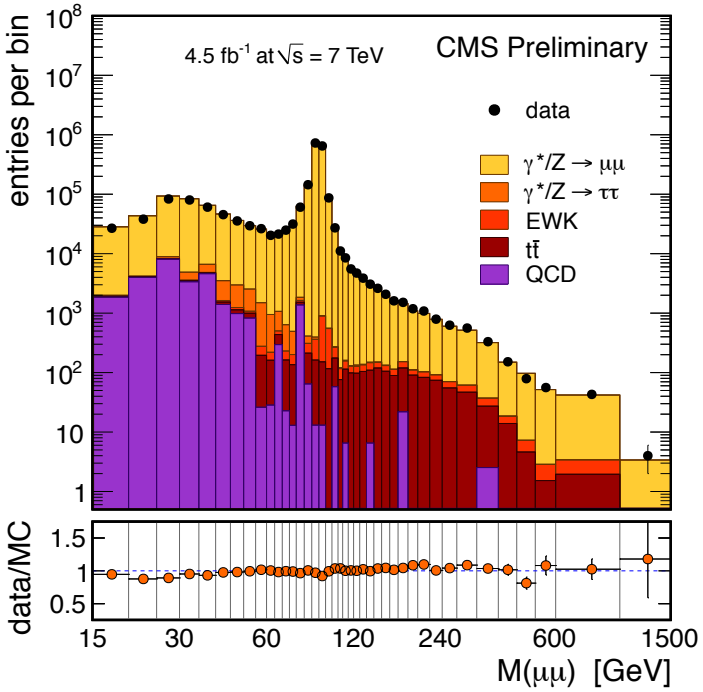


EWK-inos are the tastier fruit

- Jetty signature suffer from large QCD backgrounds
- Lepton signatures are clean
  - EWK-inos may give leptons



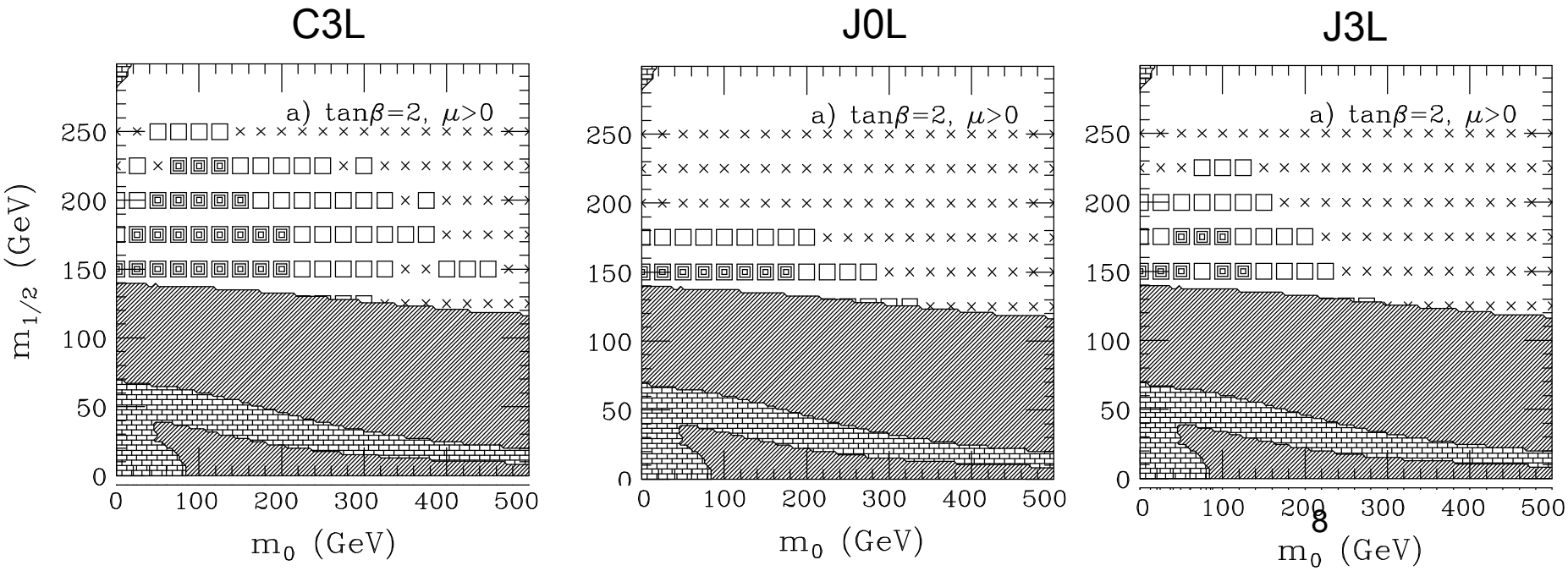




The gold-plated SUSY mode

- Run II SUSY-Higgs workshop, SUGRA WG report:
  - "the clean trilepton channel from C_1N_2 production potentially offers the greatest reach at luminosity upgrades of the Tevatron, and has, therefore, received the maximum attention"

Baer,Chen,Drees,Paige,Tata (1998)



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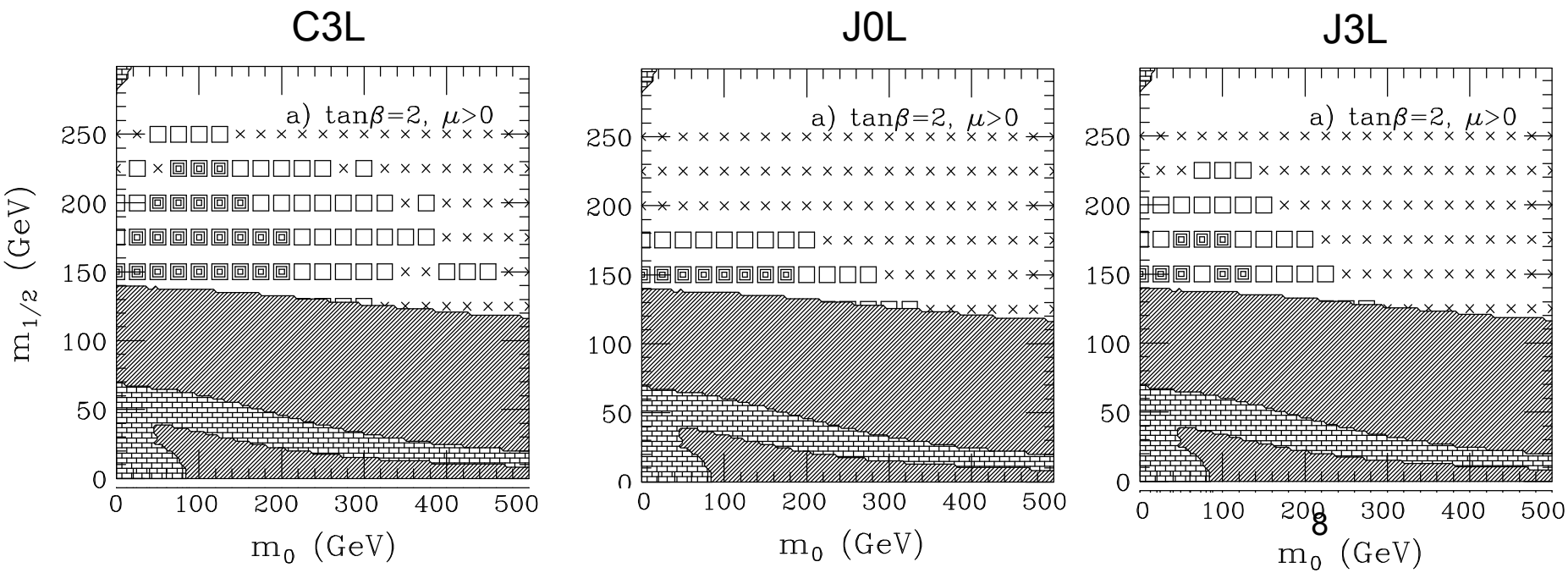
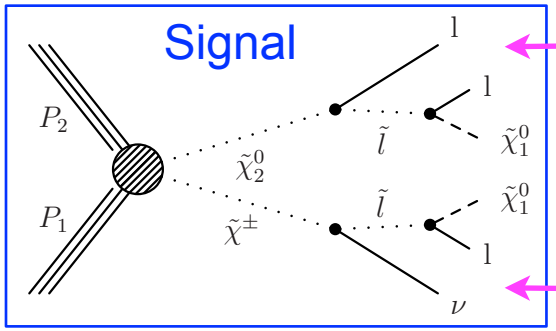
V. Barger, C. Wagner

Baer,Chen,Drees,Paige,Tata (1998)

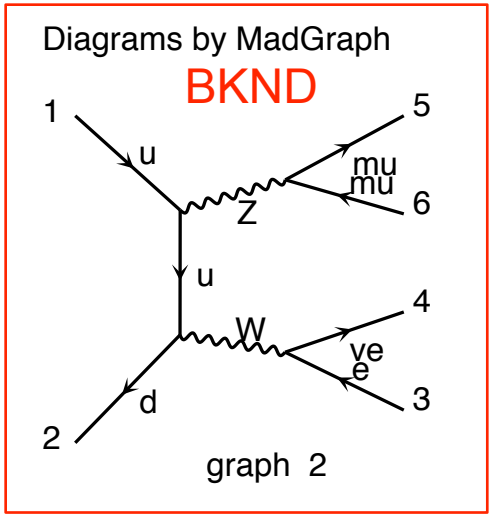


EWK-ino cuts

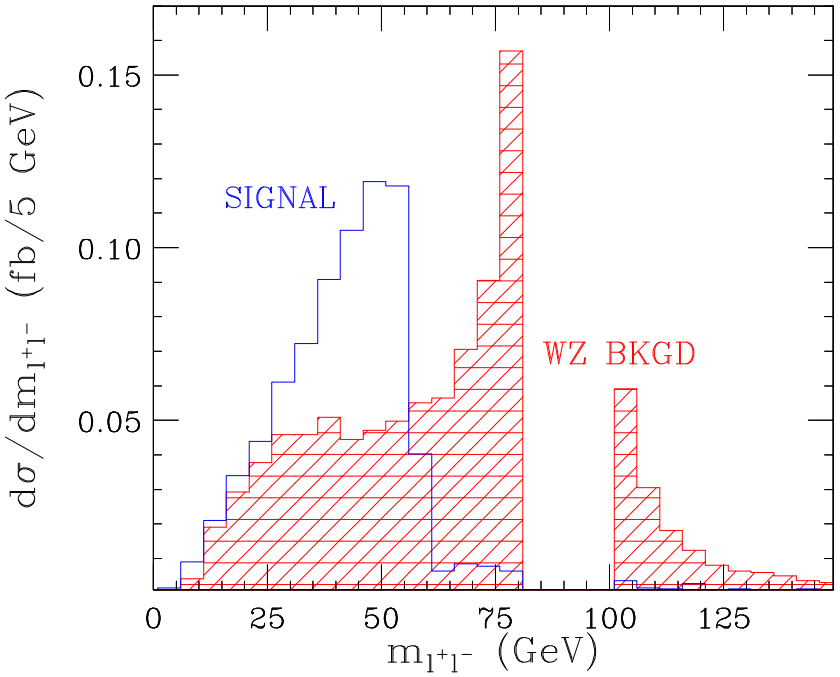


Should not form a "Z"

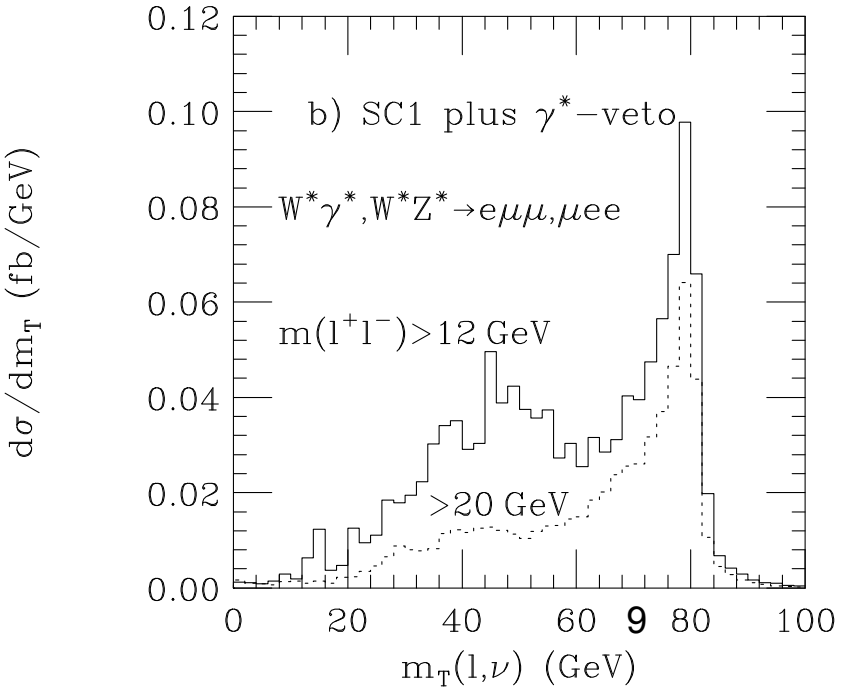
Should not form a "W"



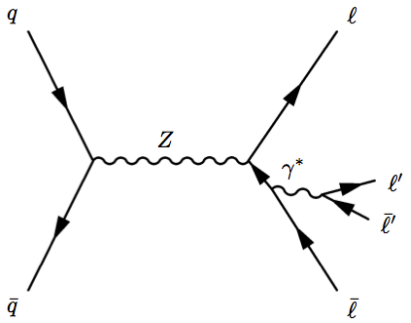
KM,Pierce (1999)

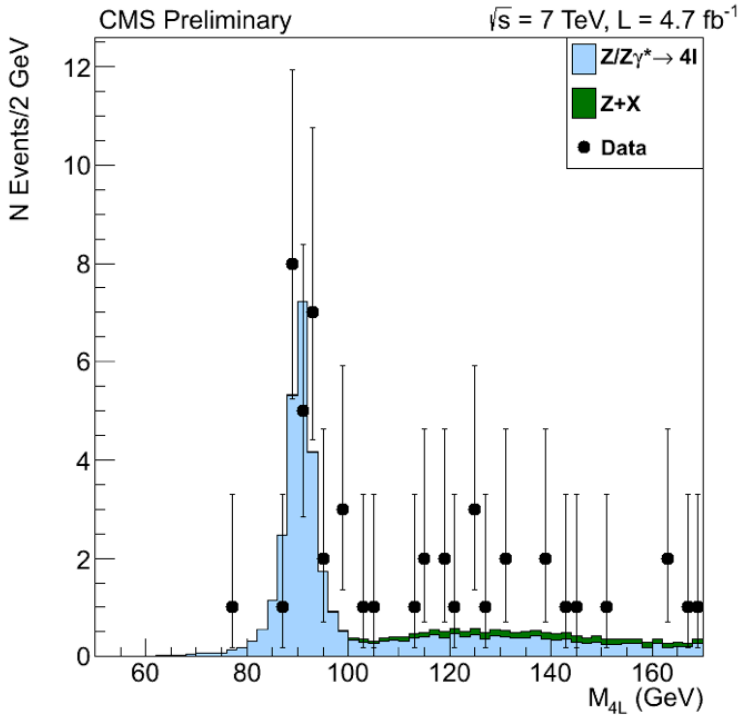


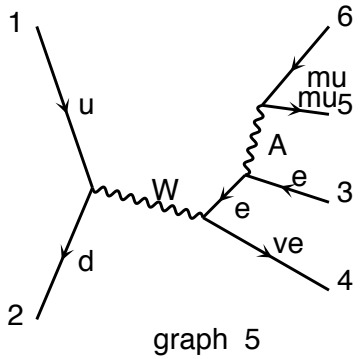
Baer,Drees,Paige,Quintana,Tata (1999)



Unintended “discoveries”







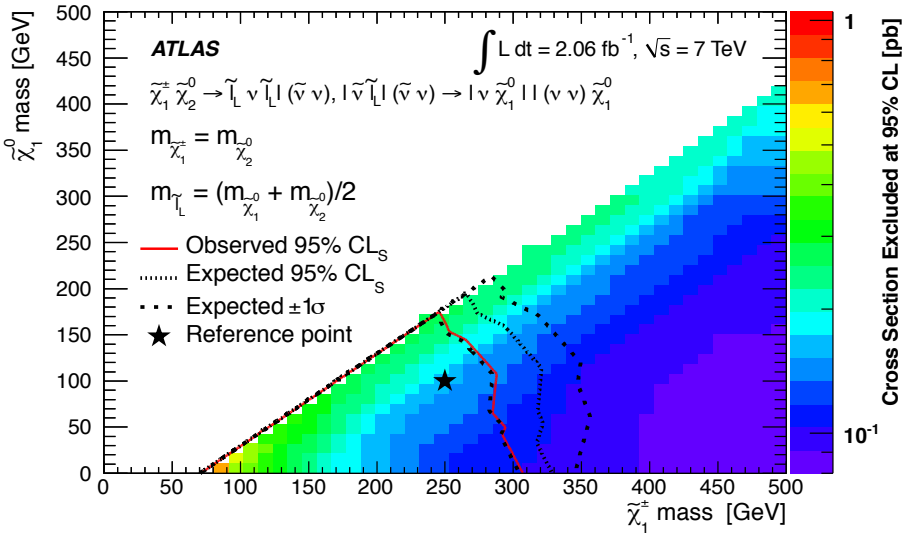
graph 5

Insert W->3L+nu discovery plot here

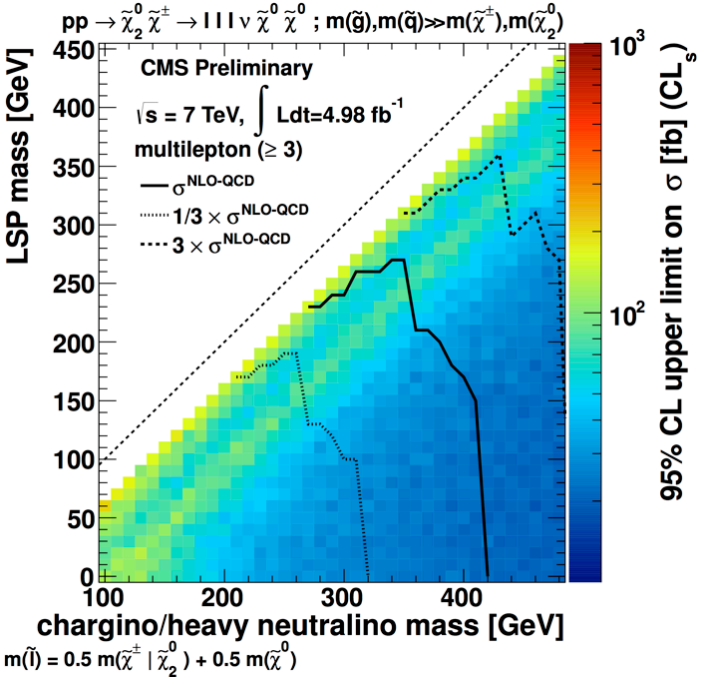
see Sunil’s talk yesterday

Simplified models of EWK-inos

- Hot off the press:



see Anadi's talk yesterday

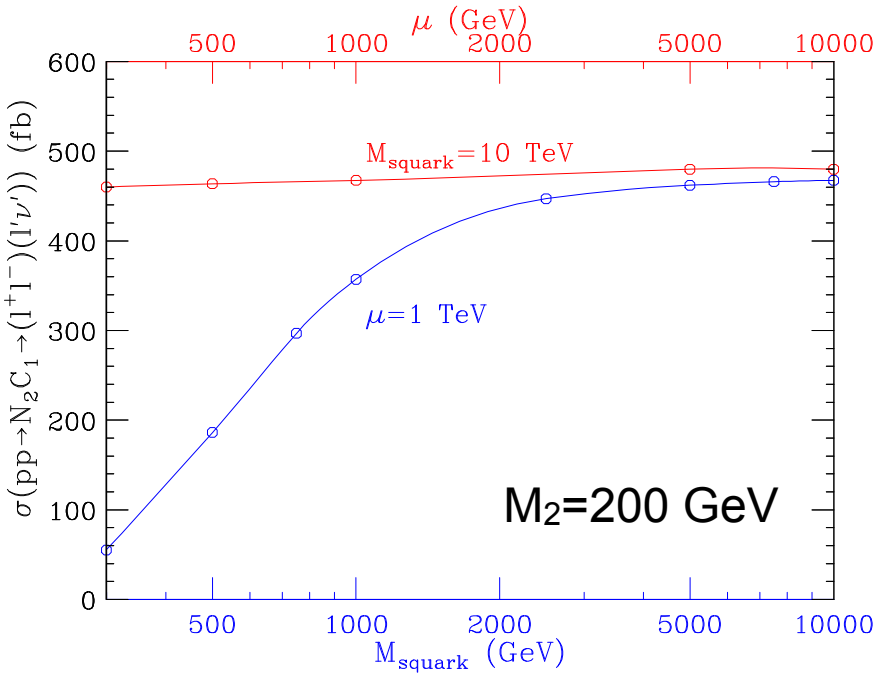


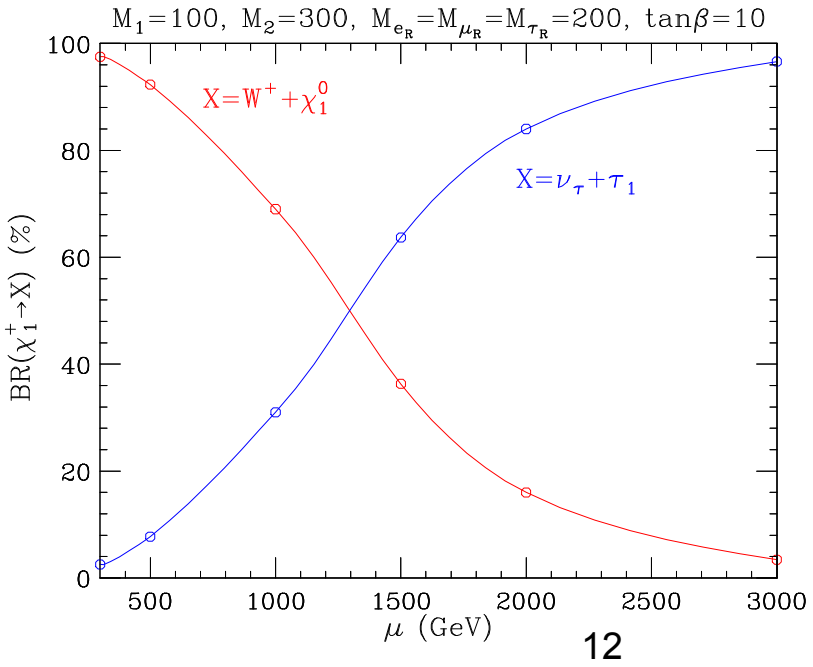
see Sunil's talk yesterday

- What about the "irrelevant" parameters?
  - squark mass
  - higgsino parameter mu

Be careful how you interpret

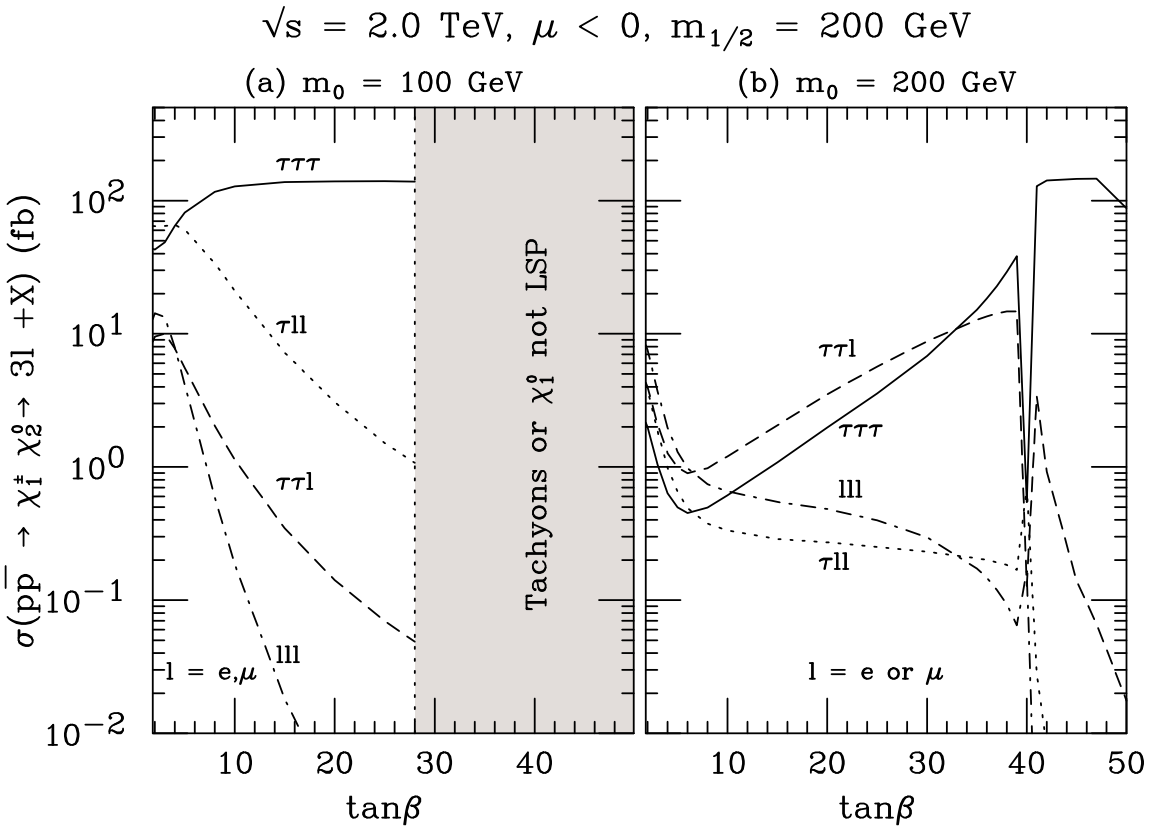
- The cross-section depends on the squark mass
  - destructive interference
- The BR's of EWK-inos to right-handed sleptons depend on the higgsino-ness of the EWK-inos
  - only tau leptons





Taus are important

- EWK-inos may decay predominantly to taus, especially at large tan beta.
  - also see talks in the tau physics session this morning

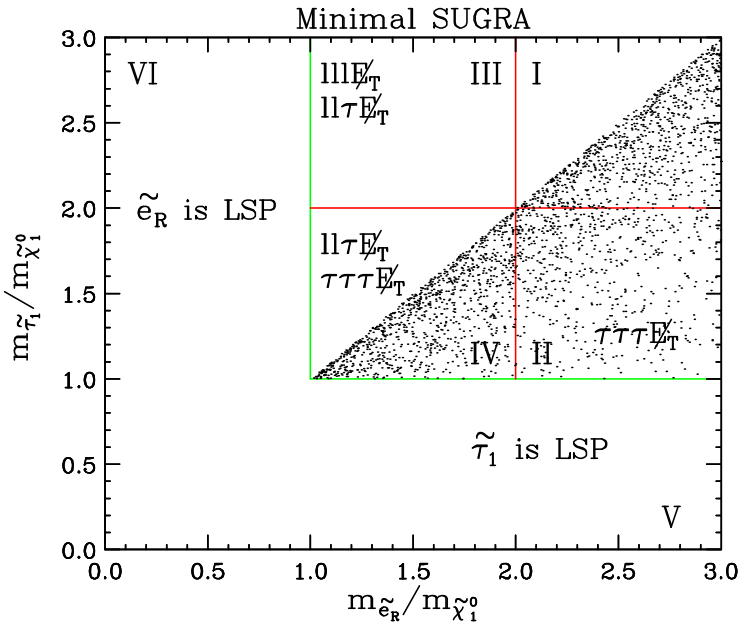


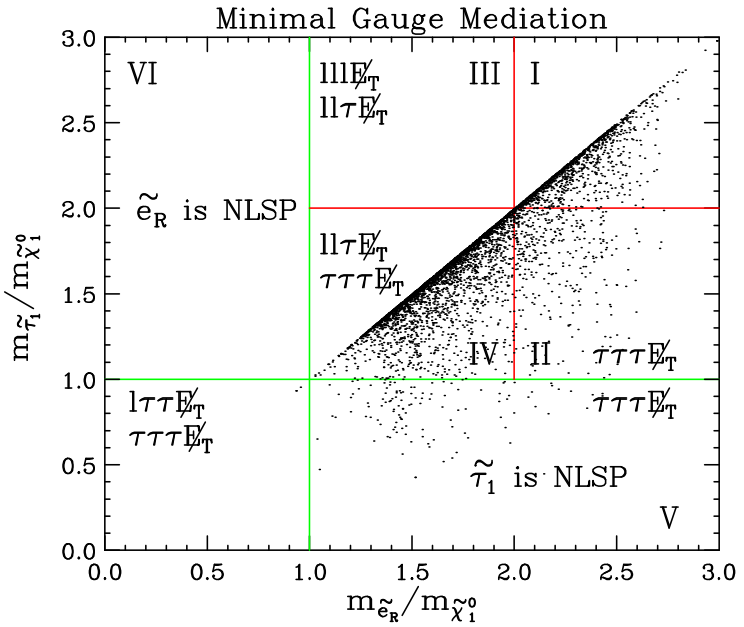
Barger,Kao,Li (1998)

Why are taus important?

- Staus are lighter than selectrons and smuons
  - stau mixing
  - Yukawa terms in the RGEs
- EWK-inos may have no other choice but decay to taus

Lykken,KM (1999)



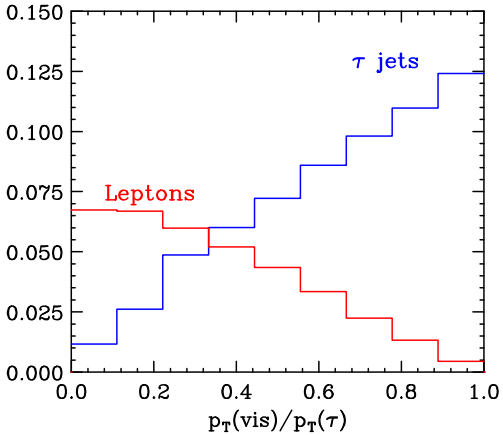


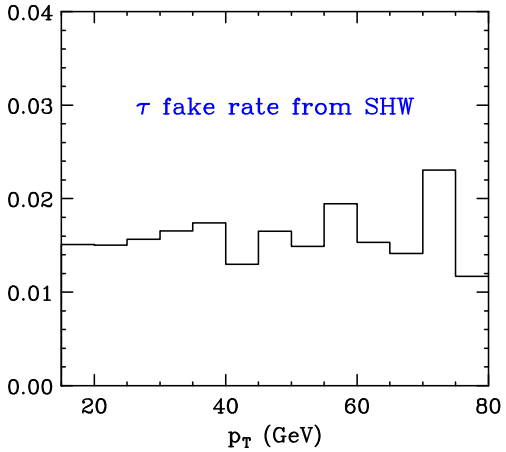
Leptons and taus from EWK-inos

- To lepton or to tau: that is the question

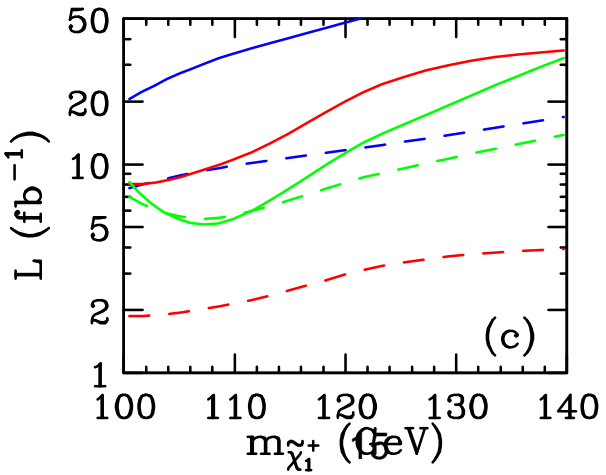
Lykken,KM (1999)

Experimental signature	Trilepton SUSY signal			
	$\tau\tau\tau$	$\tau\tau\ell$	$\tau\ell\ell$	$\ell\ell\ell$
$\tau_h\tau_h\tau_h$	0.268	—	—	—
$\ell\tau_h\tau_h$	0.443	0.416	—	—
$\ell\ell\tau_h$	0.244	0.458	0.645	—
$\ell\ell\ell$	0.045	0.126	0.355	1.00



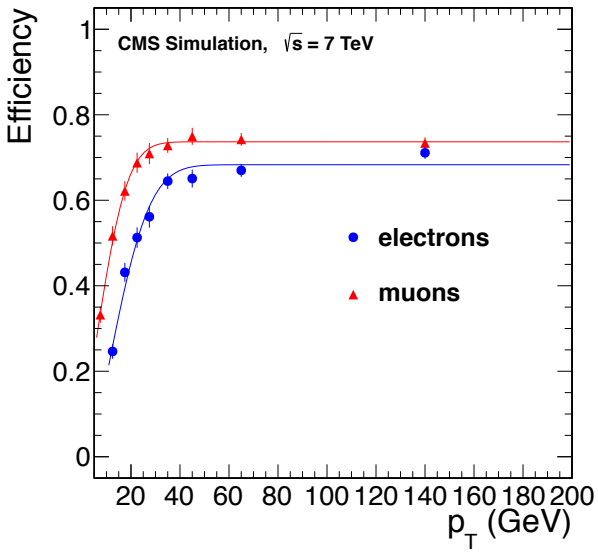


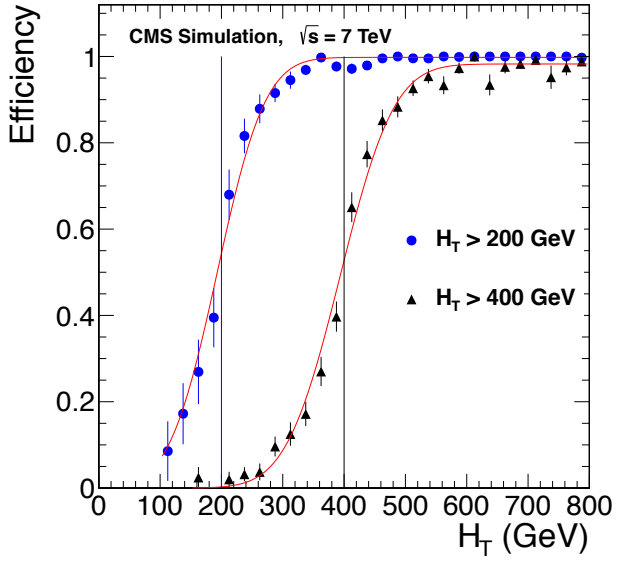
	Experimental signatures				
	$\ell\ell\ell\not{E}_T$	$\ell\ell\tau_h\not{E}_T$	$\ell^+\ell^+\tau_h\not{E}_T$	$\ell\tau_h\tau_h\not{E}_T$	$\tau_h\tau_h\tau_h\not{E}_T$
ZZ	0.196 ± 0.028	0.334 ± 0.036	0.094 ± 0.019	0.181 ± 0.027	0.098 ± 0.020
WZ	1.058 ± 0.052	1.087 ± 0.053	0.447 ± 0.034	1.006 ± 0.051	0.248 ± 0.025
WW	—	0.416 ± 0.061	—	0.681 ± 0.078	0.177 ± 0.039
$t\bar{t}$	0.300 ± 0.057	1.543 ± 0.128	0.139 ± 0.038	1.039 ± 0.105	0.161 ± 0.041
Zj	0.112 ± 0.079	7.34 ± 0.64	0.168 ± 0.097	20.3 ± 1.1	17.9 ± 1.0
Wj	—	—	—	37.2 ± 2.9	6.1 ± 1.2
$\sigma_{BG}^{\rm tot}$	1.67 ± 0.11	10.7 ± 0.7	0.85 ± 0.11	60.4 ± 3.1	24.7 ± 1.6

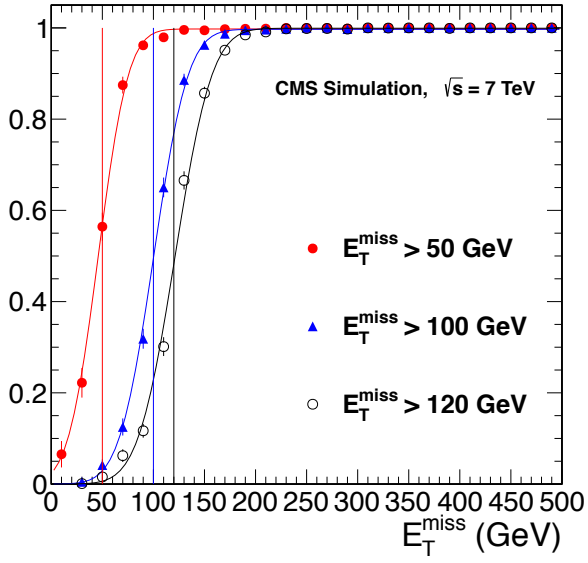


Advertisement

- How can theorists recast LHC results for other models? See Maurizio's talk.







Summary

- It is time to reach for the high hanging fruit
- Direct EWK-ino searches are already under way
- (Final states with) taus are important