LHC^{-1} = ILC ?? PROJECT UPDATE

♣ The original purpose of this project was to examine whether or not ~200 pairs of MSSM SUSY models which produced `identical’ signals at the LHC could be distinguished at the ILC.

♦ Though we are still attacking this question this project has morphed into something far larger…we are performing a general study of the signals and backgrounds for hundreds of random MSSM models at ILC which provides a unique opportunity to examine, e.g., cuts, detector and simulation properties & our basic assumptions about SUSY signatures.

♠ We’ve had many surprises and have learned many lessons…

C.F. Berger, J. Gainer, J.L. Hewett, B. Lillie, TGR

LHC Inverse Problem

Generate blind SUSY data and map it back to parameters in the fundamental Lagrangian

- **Generated *many* models within MSSM for 10 fb^{-1} @ LHC (Pythia**
- **For 15 parameters:**

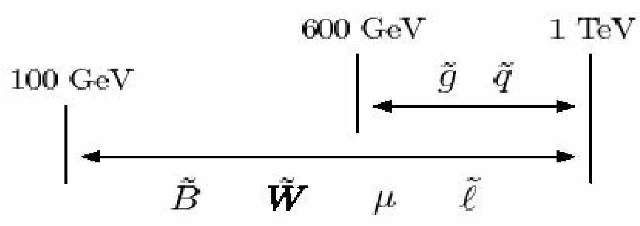
Inos : $M_1,\ M_2,\ M_3,\ \mu$

Squarks : $m_{\tilde{Q}_{1,2}},\ m_{\tilde{U}_{1,2}},\ m_{\tilde{D}_{1,2}},\ m_{\tilde{Q}_3},\ m_{\tilde{t}_R},\ m_{\tilde{b}_R}$ + tan β

Sleptons : $m_{\tilde{L}_{1,2}},\ m_{\tilde{E}_{1,2}},\ m_{\tilde{L}_3},\ m_{\tilde{\tau}_R}$

With flat priors..

Within the constraints:



$2 < \tan\beta < 50$

kept 1st two scalar generations degenerate

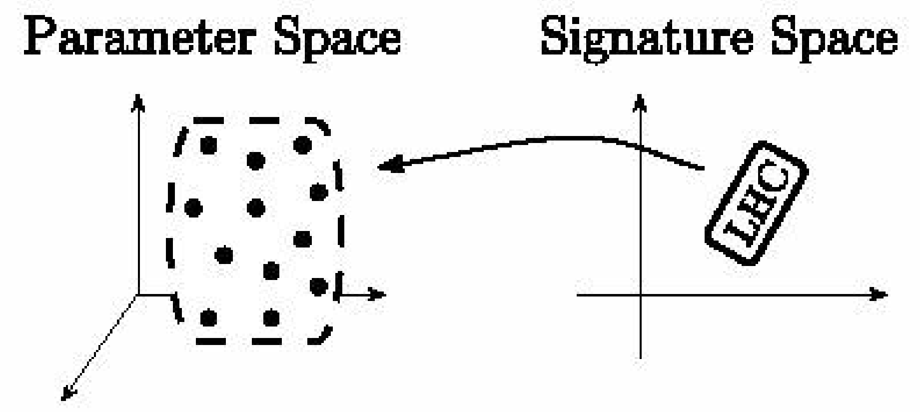
- **Used ~1808 LHC MSSM `Observables'**
  - **Rate counting, kinematic distributions**

- **NO SM Backgrounds!**

Arkani-Hamed, Kane, Thaler, Wang, hep-ph/0512190

LHC Inverse Problem: Results

- Main result: 283 pairs of models (383 distinct models*) were found to be indistinguishable, i.e., had the same `signature'…many more than by a statistical analysis..
  - A `signature' maps back into a number of small islands in parameter space

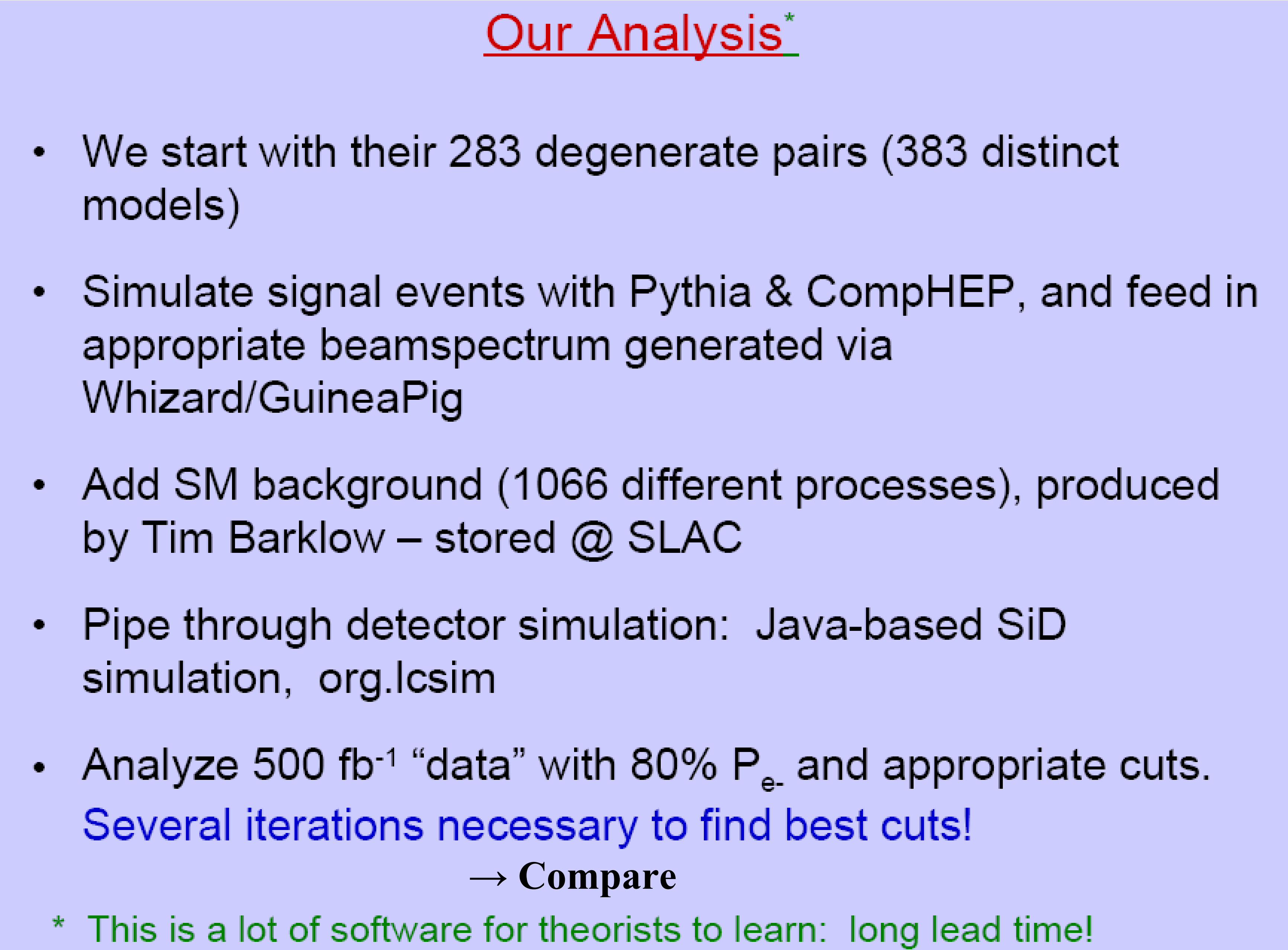


* as we will see only 242 models are physical

- Begs the question: Can the ILC resolve these
  - We will quantify this…..

A Reminder :

From



Our Analysis*

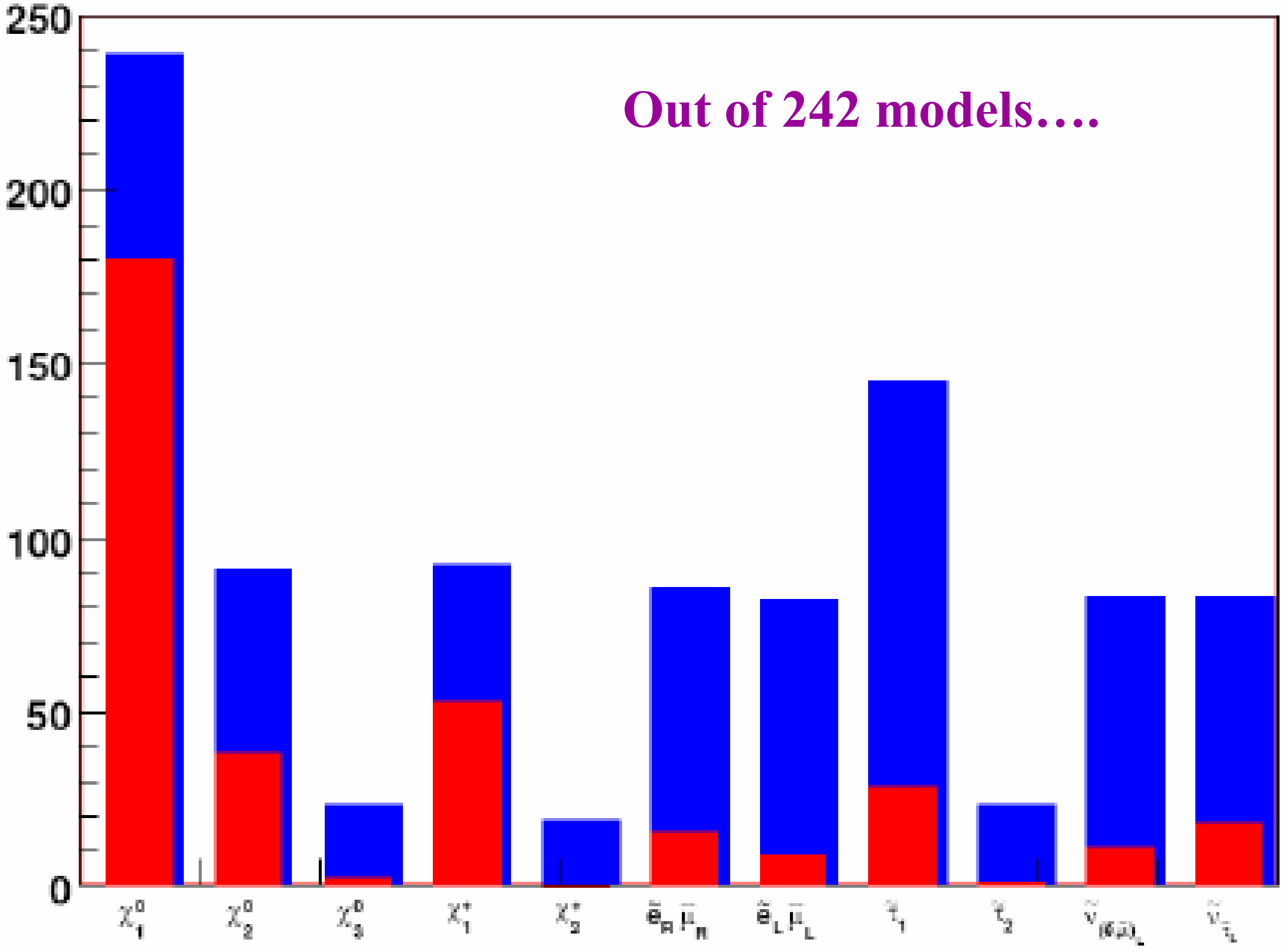
- We start with their 283 degenerate pairs (383 distinct models)
- Simulate signal events with Pythia & CompHEP, and feed in appropriate beamspectrum generated via Whizard/GuineaPig
- Add SM background (1066 different processes), produced by Tim Barklow – stored @ SLAC
- Pipe through detector simulation: Java-based SiD simulation, org.lcsim
- Analyze 500 fb^{-1} “data” with 80% P_{e-} and appropriate cuts.

  Several iterations necessary to find best cuts!

→ **Compare**

* This is a lot of software for theorists to learn: long lead time!

Lesson One: Many models do not produce visible signals at 500GeV



Out of 242 models….

Accessible at 500 GeV, 1 TeV c.m. energy

Let’s look at the

LESSON ONE :

	500 GeV	Visible	1 TeV
selectrons or smuons	22	15?	116
staus	27	6?	125
All slepton types	7	6?	55
χ^+_1	53	15?	78
χ^+_1 +smuons	2	?	12
χ^+_1 + staus	8	?	12
$\chi^+_1\ \chi^-_2$	0	0	16
$\chi^0_1\ \chi^0_1$ *only*	99	0	1
$\chi^0_1\ \chi^0_2$	46	3?	178
nothing	59	0	1

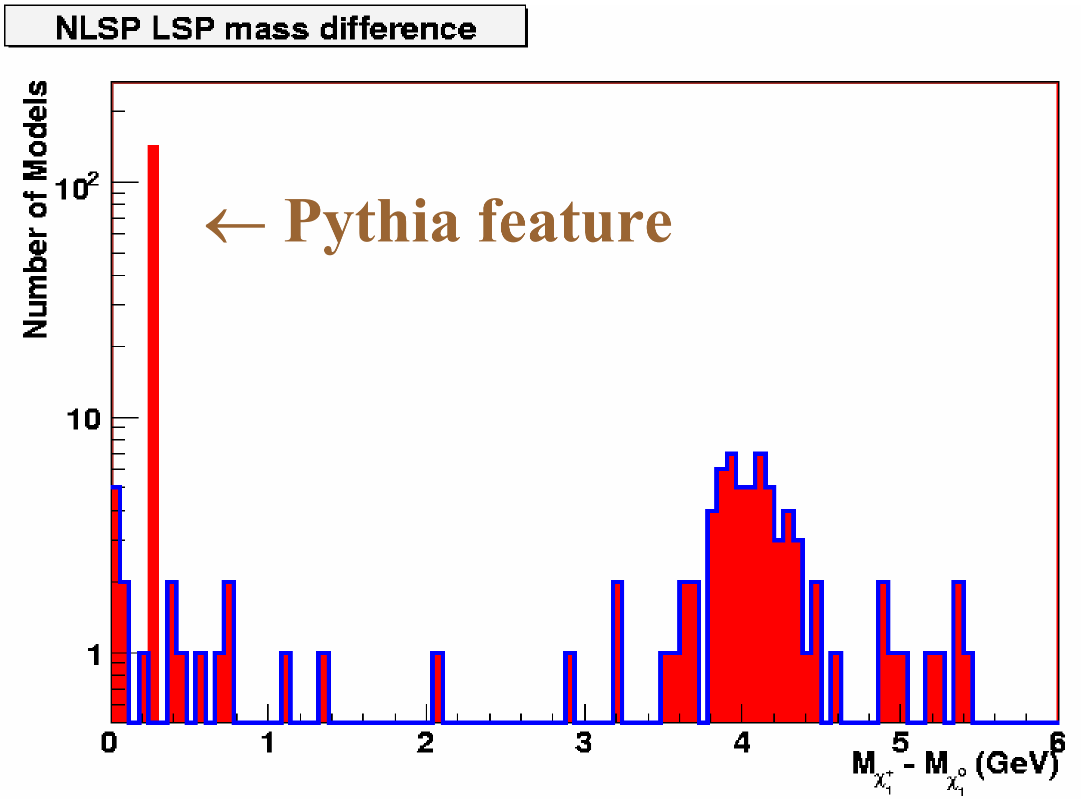
Kinematic accessibility does not equal observability of models :

Out of 242 models, at 500 GeV, 59+99=158/242 = 65 % have NO signal observable…the percentage is actually higher (~75 % !) after some further investigation as we will see. this fraction is much smaller at 1 TeV .

→ `visible' here is the actual number of models where a signal is observable over background

This may be very strong argument for 1 TeV as soon as possible…

LESSON TWO : BEWARE OF BLIND USE OF PYTHIA, PART I:



← Pythia feature

Chargino – LSP Mass Difference

In PYTHIA6.324 or earlier, if the χ_1^+ is calculated to be lighter than the LSP then the code automatically, and without ANY warning, resets the χ_1^+ mass to of the LSP+ $2m_\pi$. This happens 141/383 original model cases !!

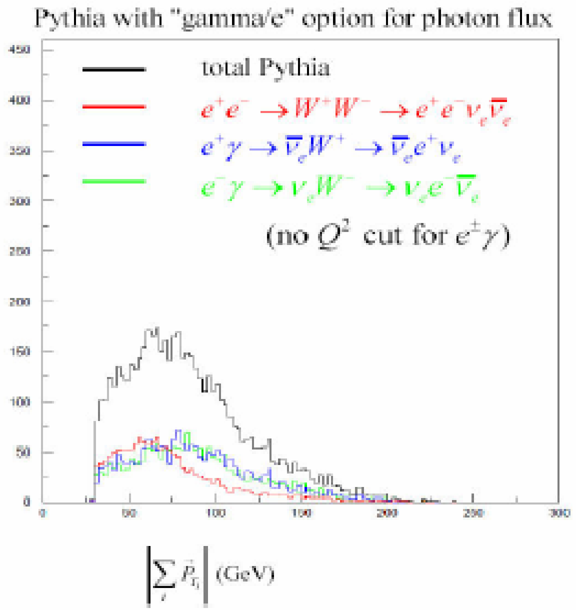
This reduces our sample: 383→242

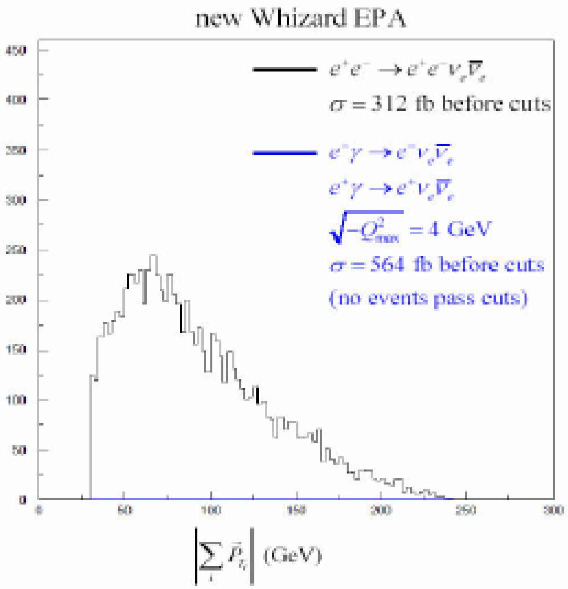
This issue has now been with in the latest version of PYTHIA (thanks to Steve &

BEWARE OF BLIND USE OF PYTHIA , PART II : PYTHIA UNDERESTIMATES BACKGROUNDS

- Using full matrix elements makes a difference
  - Here we compare standard model background to our selectron analysis as calculated in PYTHIA and WHIZARD
  - Cross section after cuts with WHIZARD is 30% higher
  - Tail is higher
  - Difference arises from using explicit matrix element for ee → ee$\nu\nu$ instead of decaying on-shell resonances

$$e^-_{pol} = 0 \quad \sqrt{s} = 500 \text{ GeV} \quad 250 \text{ fb}^{-1}$$


Pythia with "gamma/e" option for photon flux


new Whizard EPA

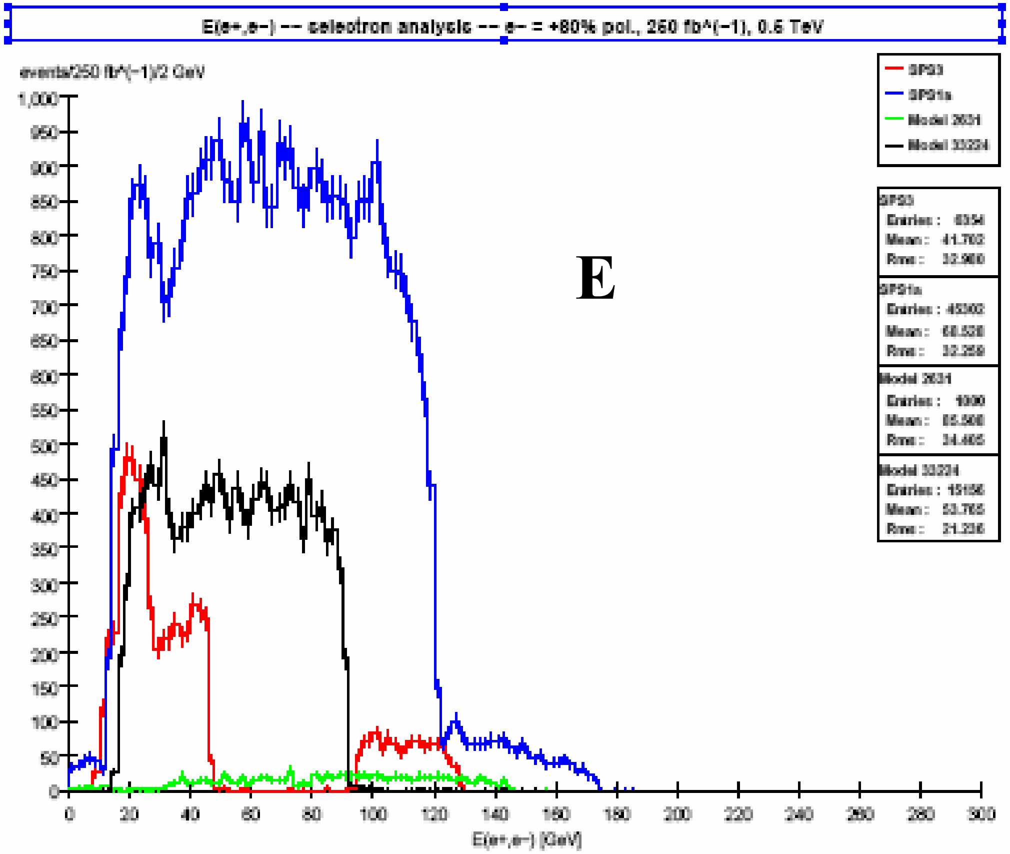
Thanks to Tim Barklow

→ using full backgrounds is important !
Probably also true for the signal..!

LESSON THREE :

SPS1a is SPECIAL .. Part I :

Looking at 100s of random MSSM models, we find that most have smaller rates than the SPS points commonly studied

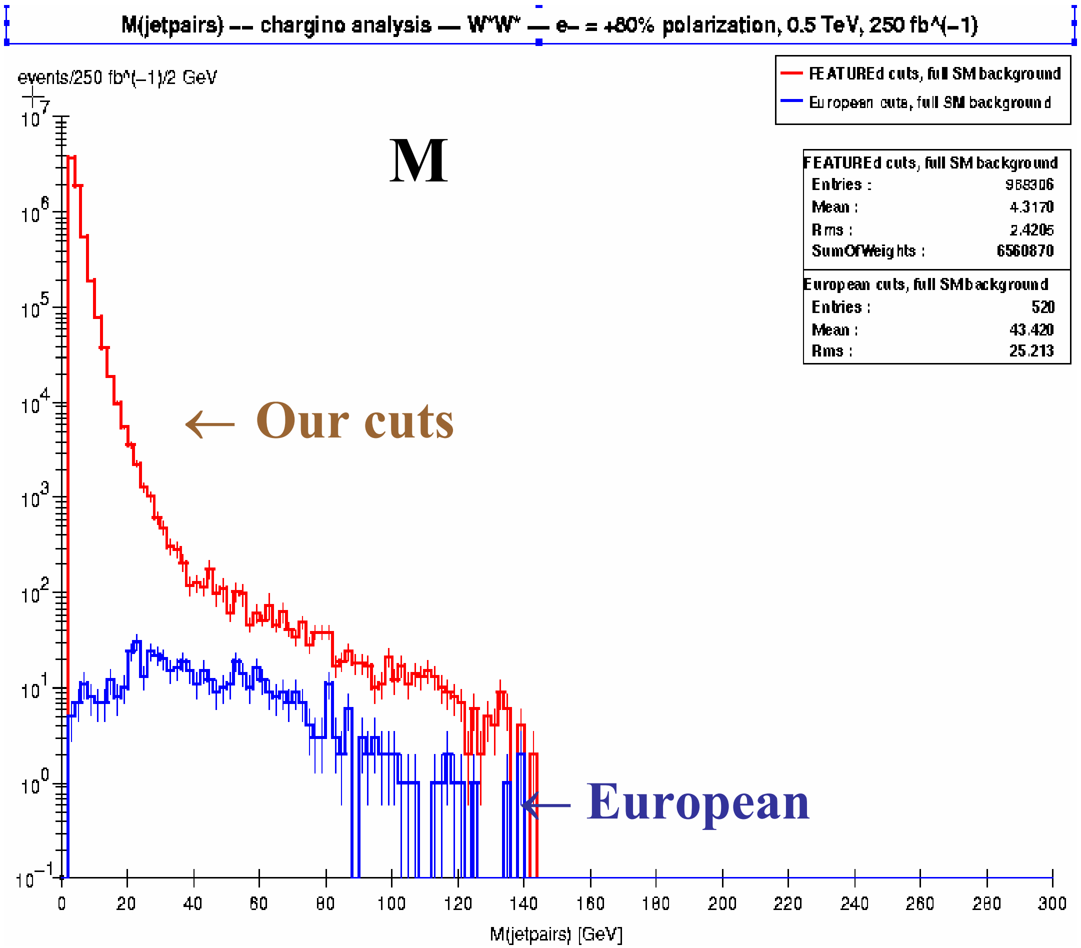


It will be much more difficult to see SUSY particles in general than in the well-studied specialized points…in some cases signal rates are over 50x smaller than in the SPS1a scenario…

But we can still see sometimes…

SPS1a is SPECIAL .. Part

The `standard' cuts not particularly



M

← Our cuts

← European

We cannot use the cuts that have been developed historically for the SPS1a point….while they do help reduce backgrounds we find that for some analyses they kill all the signals from our models !

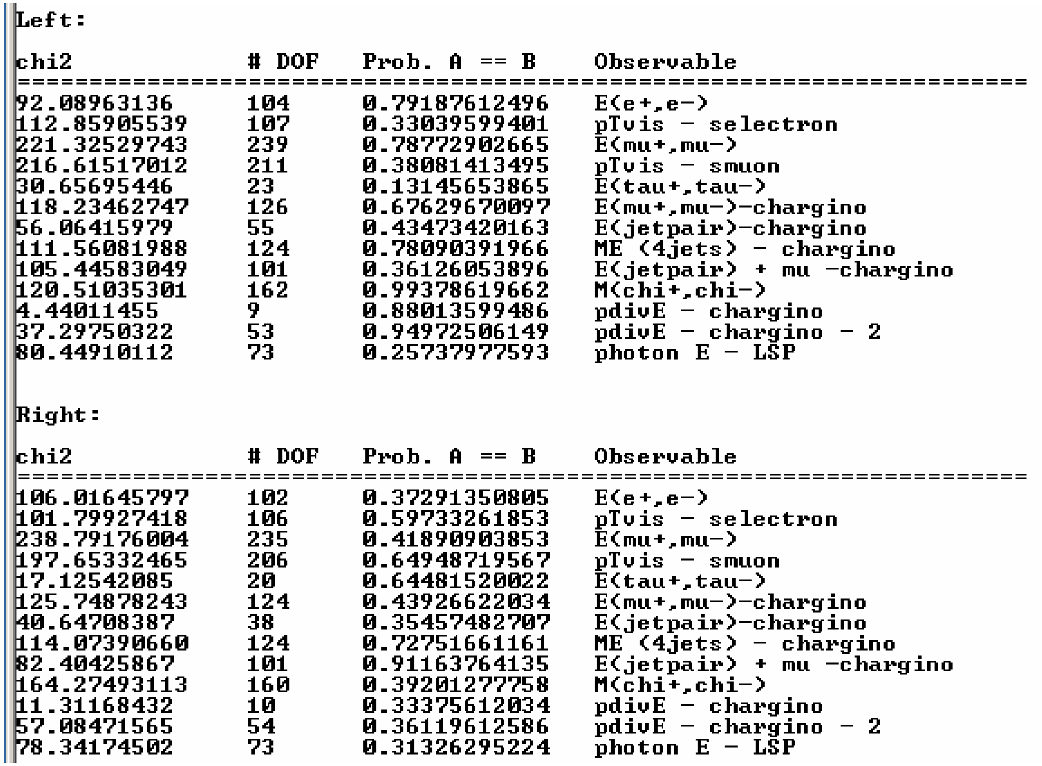
We thus need to develop and employ our own universal cuts that generally lead to larger backgrounds to SUSY…

LESSON

It is important to compare, e.g., two SM background samples to make the analysis procedures are correct….and no additional features are

This is a comparison of two 250 fb^{-1} background samples for both polarizations, (almost) analysis by analysis…

Looks



```
Left:

chi2            # DOF   Prob. A == B    Observable
======================================================================
92.08963136     104     0.79187612496   E(e+,e-)
112.85905539    107     0.33039599401   pTvis - selectron
221.32529743    239     0.78772902665   E(mu+,mu-)
216.61517012    211     0.38081413495   pTvis - smuon
30.65695446     23      0.13145653865   E(tau+,tau-)
118.23462747    126     0.67629670097   E(mu+,mu-)-chargino
56.06415979     55      0.43473420163   E(jetpair)-chargino
111.56081988    124     0.78090391966   ME (4jets) - chargino
105.44583049    101     0.36126053896   E(jetpair) + mu -chargino
120.51035301    162     0.99378619662   M(chi+,chi-)
4.44011455      9       0.88013599486   pdivE - chargino
37.29750322     53      0.94972506149   pdivE - chargino - 2
80.44910112     73      0.25737977593   photon E - LSP


Right:

chi2            # DOF   Prob. A == B    Observable
======================================================================
106.01645797    102     0.37291350805   E(e+,e-)
101.79927418    106     0.59733261853   pTvis - selectron
238.79176004    235     0.41890903853   E(mu+,mu-)
197.65332465    206     0.64948719567   pTvis - smuon
17.12542085     20      0.64481520022   E(tau+,tau-)
125.74878243    124     0.43926622034   E(mu+,mu-)-chargino
40.64708387     38      0.35457482707   E(jetpair)-chargino
114.07390660    124     0.72751661161   ME (4jets) - chargino
82.40425867     101     0.91163764135   E(jetpair) + mu -chargino
164.27493113    160     0.39201277758   M(chi+,chi-)
11.31168432     10      0.33375612034   pdivE - chargino
57.08471565     54      0.36119612586   pdivE - chargino - 2
78.34174502     73      0.31326295224   photon E - LSP
```

BTW: even with LCSIM it takes us ~3 weeks to generate a full background sample with a fixed set of cuts since the background files from TimB are so large (~ 1.7TB) even the `toaster'…this drastically reduces the number of tests we can perform…

LESSON FIVE :

To cover all the possibilities many simultaneous analyses are required:

(i) Selectron/smuon/stau pairs → SM analogues + missing E

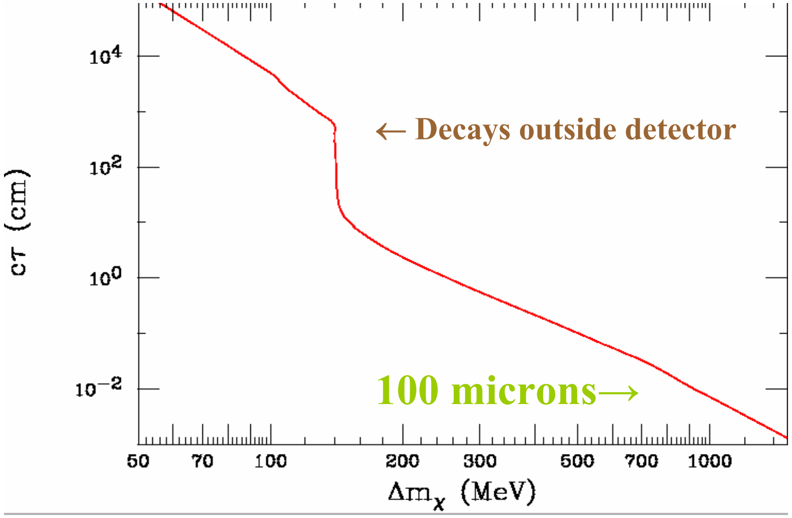
(ii) Radiative neutralino pairs using tagged γ's

(iii) $\chi_2^0\ \chi_1^0 \rightarrow$ missing E + Z/H (jj /l^+l^-)…this analysis was added recently

(iv) Sneutrino pairs → 4jets+ lepton pair + missing E … another new one

(v) $\chi_1^+\ \chi_1^-$: analyses will depend on the

Critical parameter for charginos: $\Delta m = m_{\chi_1^\pm} - m_{\chi_1^0}$



← Decays outside detector

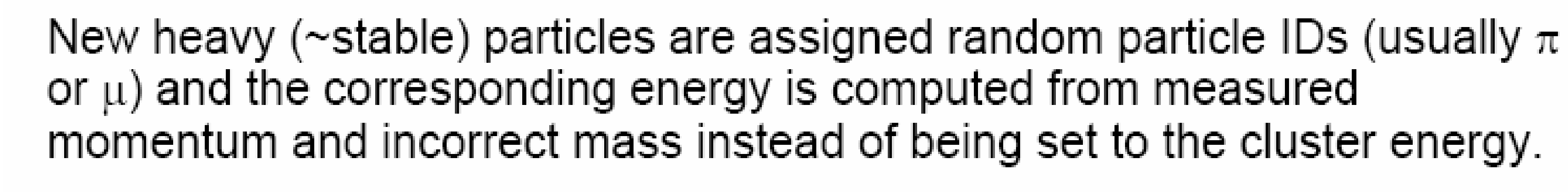
100 microns→

(a) → if $\Delta m < m_\pi$ we need to do a stable charged particle search

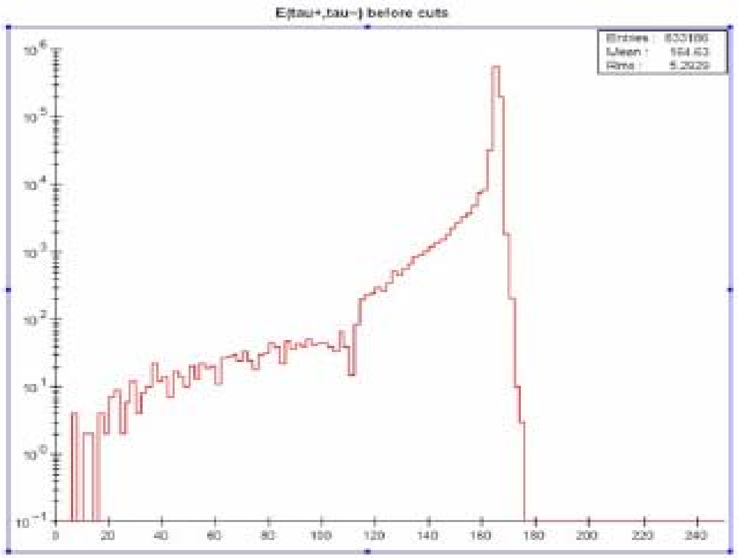
WHICH LEADS TO… LESSON SIX :

From

Watch out when these stable particles pass the cuts in other analyses as they to apparent violations of energy conservation….and funny background



New heavy (~stable) particles are assigned random particle IDs (usually π or μ) and the corresponding energy is computed from measured momentum and incorrect mass instead of being set to the cluster energy.



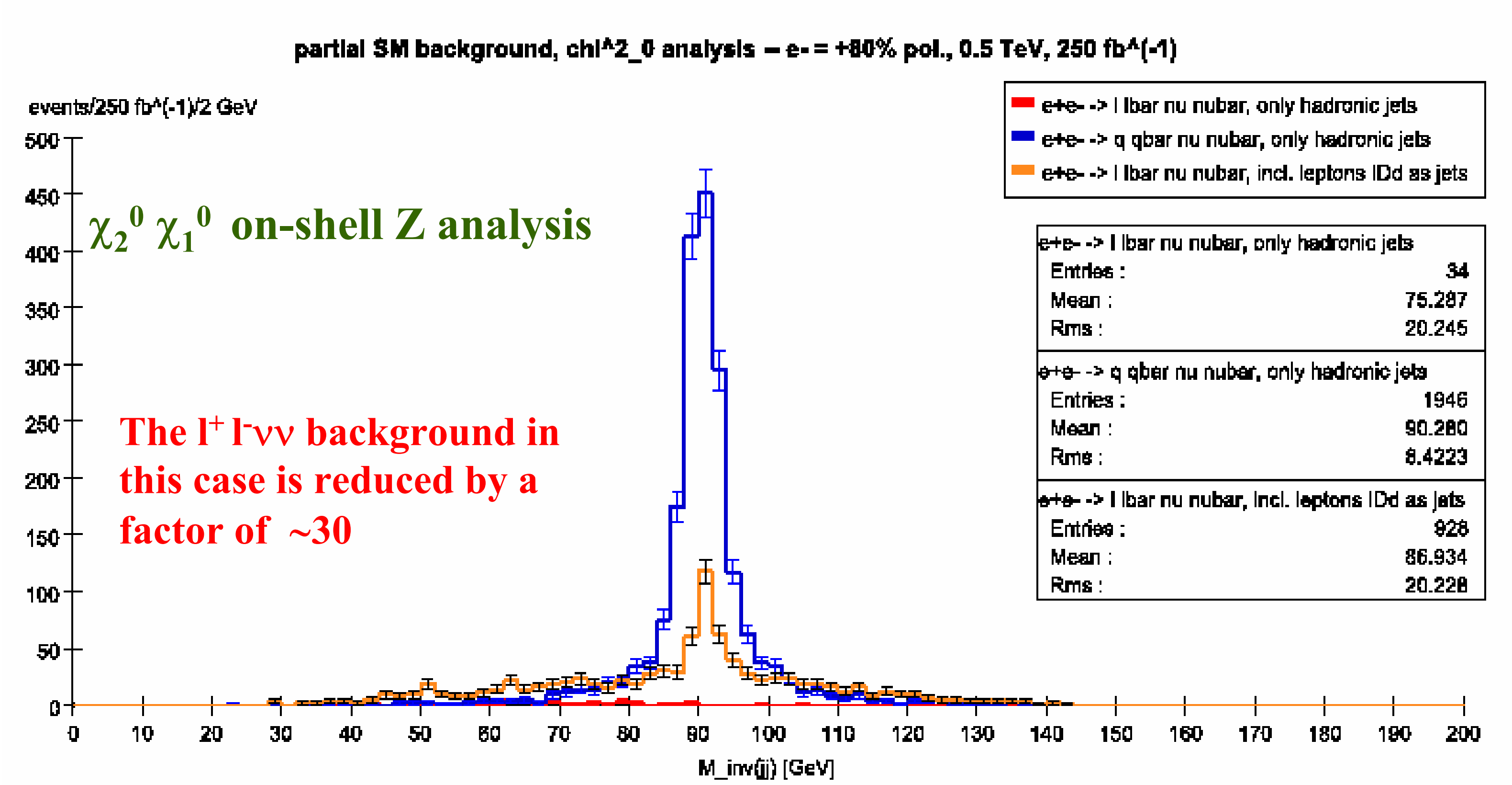
Plot of jet events from specific SUSY model with 80% left-handed polarization.

For example, in this stau analysis we are looking for jj+missing E. The stable χ_1^+ in this model yields a distribution with $<E_j>$=164.69 GeV while the LSP mass is 187.19 GeV. This violates energy conservation by ~20 GeV !!

But this also leads

LESSON SEVEN :

Electrons, muons, photons and any stable charged particles are tagged as `jets' by the vanilla lcsim. These are not jets, i.e., they are not hadrons. is a contamination in the stau, neutralino and chargino analyses to both signal and backgrounds….this is what happened on the previous slide. needed to remove these fake jets with our own algorithms.



$\chi_2^0\ \chi_1^0$ on-shell Z analysis

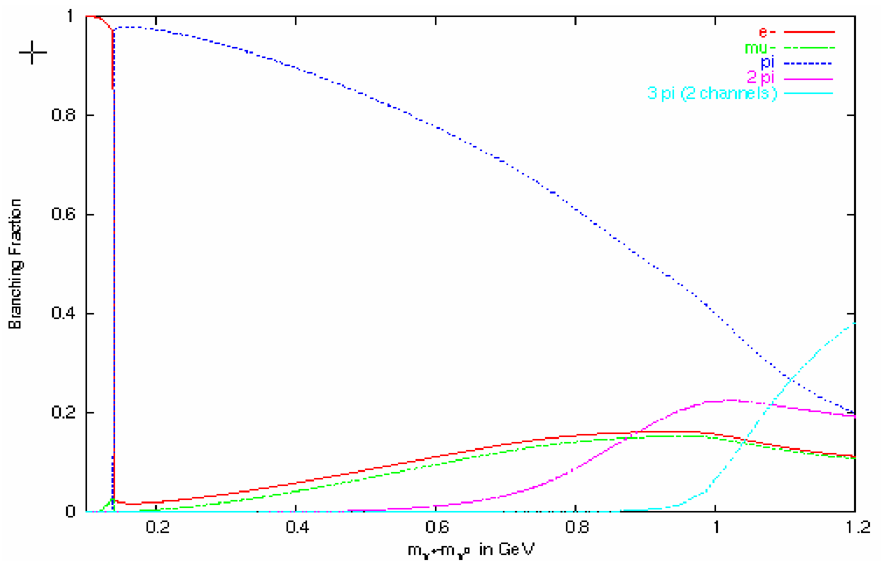
The $l^+ l^- \nu\nu$ background in this case is reduced by a factor of ~30

LESSON SEVEN :

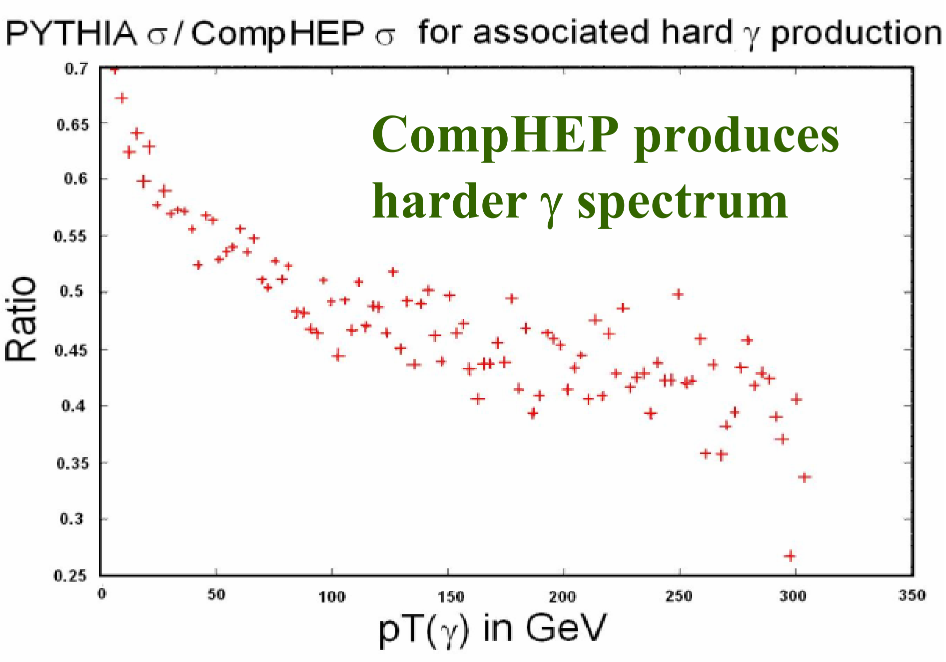
The vanilla version of lcsim has the y_{cut} value in the jet set too low and needs to be increased otherwise too many will be produced in both the signals and backgrounds.

Analyses Continued

(b) When $m_\pi < \Delta m <$ ~1 GeV the chargino decays to soft hadrons which tag by a hard photon. A full matrix element calculation is important here…



Δm

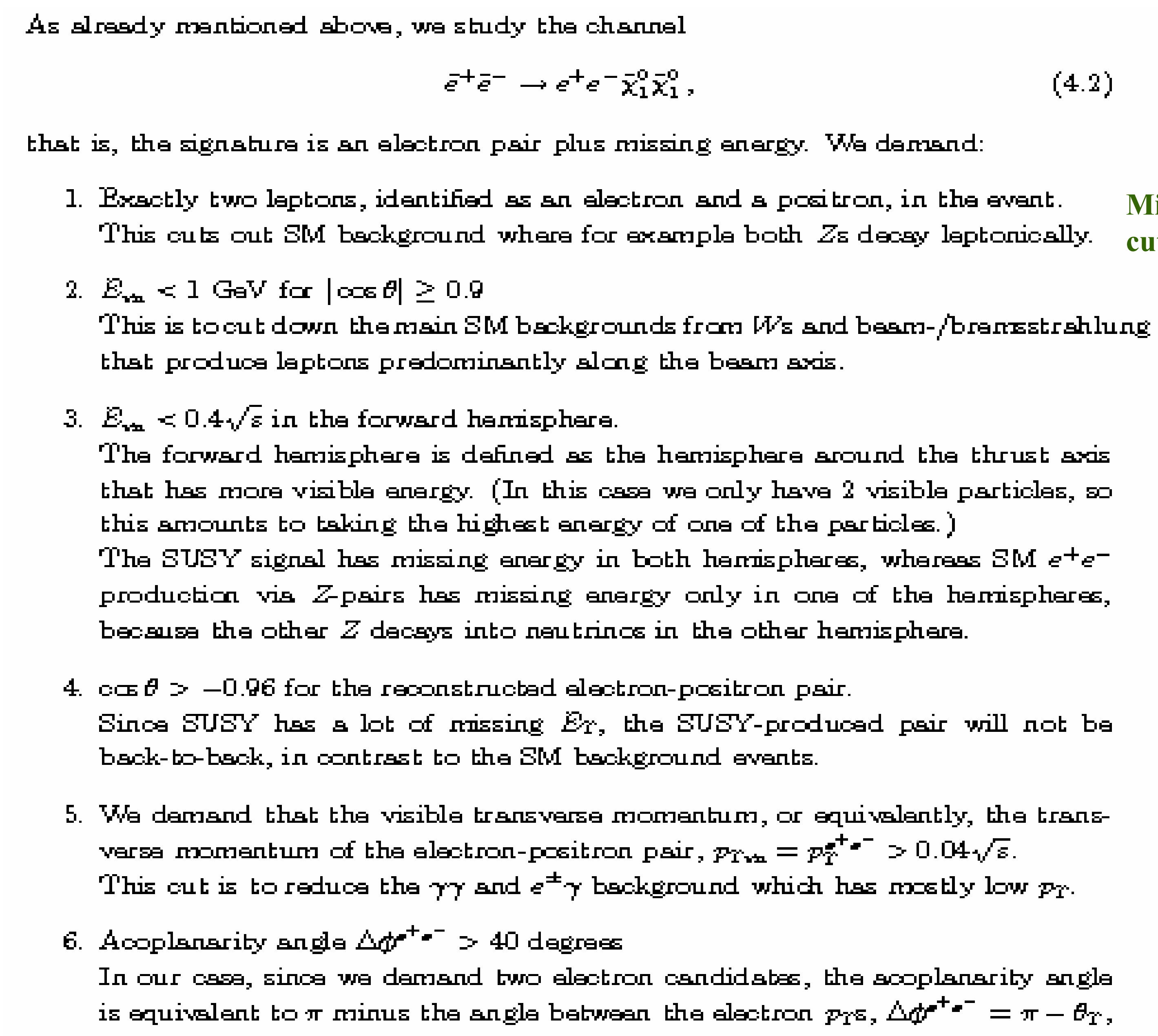

PYTHIA σ / CompHEP σ for associated hard γ production

CompHEP produces harder γ spectrum

(c) For larger Δm, we look for chargino decays through real or virtual W's or through smuons which lead to (4j/jj+μ/μμ)+ missing E final states. There are multiple sub-analyses here depending on the specific final state and W virtuality.

Now for some

Sample Analysis Cuts :



As already mentioned above, we study the channel

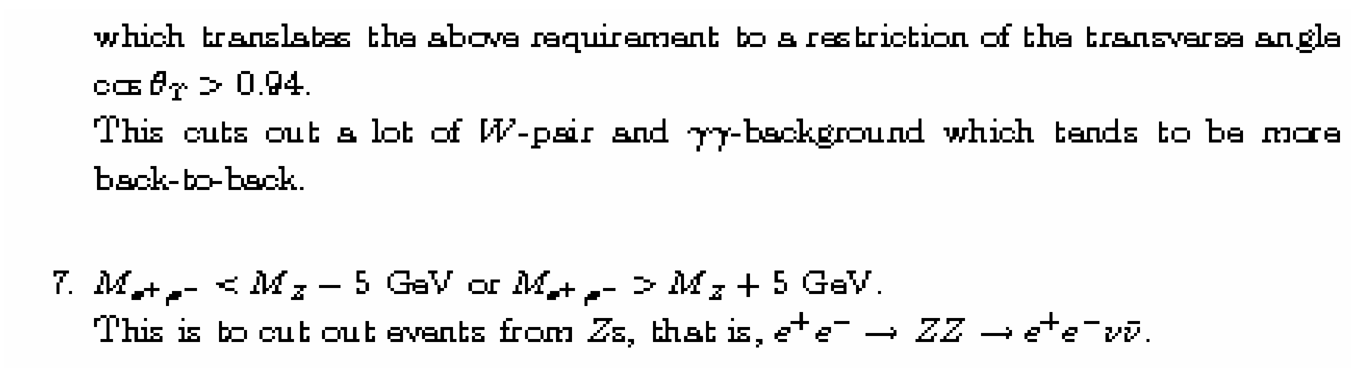
$$\tilde{e}^+\tilde{e}^- \longrightarrow e^+e^-\tilde{\chi}_1^0\tilde{\chi}_1^0 , \qquad (4.2)$$

that is, the signature is an electron pair plus missing energy. We demand:

1. Exactly two leptons, identified as an electron and a positron, in the event. This cuts out SM background where for example both Zs decay leptonically.
2. $E_{vis} < 1$ GeV for $|\cos\theta| \geq 0.9$ This is to cut down the main SM backgrounds from Ws and beam-/bremsstrahlung that produce leptons predominantly along the beam axis.
3. $E_{vis} < 0.4\sqrt{s}$ in the forward hemisphere. The forward hemisphere is defined as the hemisphere around the thrust axis that has more visible energy. (In this case we only have 2 visible particles, so this amounts to taking the highest energy of one of the particles.) The SUSY signal has missing energy in both hemispheres, whereas SM e^+e^- production via Z-pairs has missing energy only in one of the hemispheres, because the other Z decays into neutrinos in the other hemisphere.
4. $\cos\theta > -0.96$ for the reconstructed electron-positron pair. Since SUSY has a lot of missing $\not{E}_T$, the SUSY-produced pair will not be back-to-back, in contrast to the SM background events.
5. We demand that the visible transverse momentum, or equivalently, the transverse momentum of the electron-positron pair, $p_{T_{vis}} = p_T^{e^+e^-} > 0.04\sqrt{s}$. This cut is to reduce the $\gamma\gamma$ and $e^{\pm}\gamma$ background which has mostly low p_T.
6. Acoplanarity angle $\Delta\phi^{e^+e^-} > 40$ degrees In our case, since we demand two electron candidates, the acoplanarity angle is equivalent to π minus the angle between the electron p_Ts, $\Delta\phi^{e^+e^-} = \pi - \theta_T$,

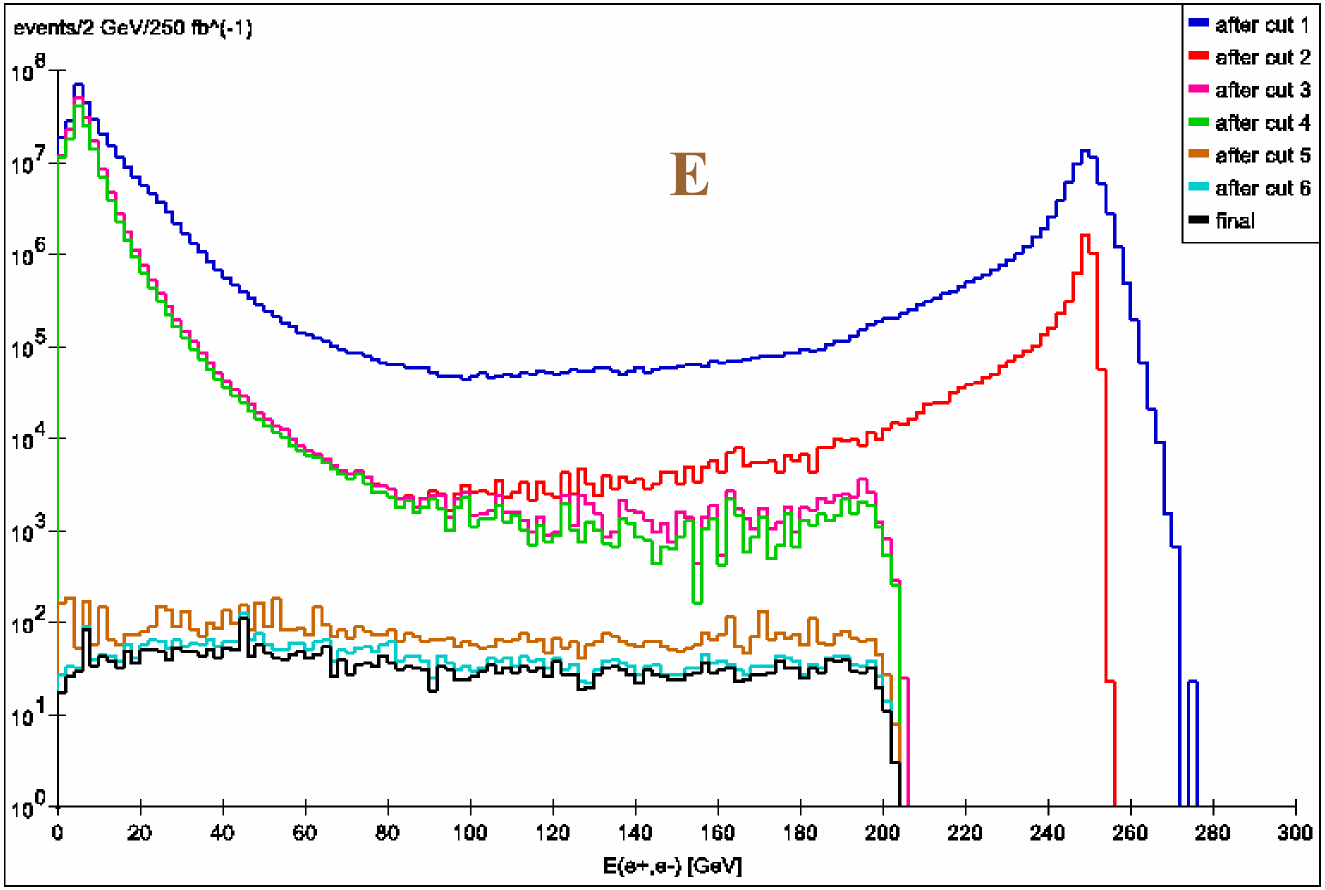
Minimal cuts applied

Sample Analysis Cuts : Selectrons (cont.)



which translates the above requirement to a restriction of the transverse angle $\cos\theta_T > 0.94$.
This cuts out a lot of W-pair and $\gamma\gamma$-background which tends to be more back-to-back.

7. $M_{e^+e^-} < M_Z - 5$ GeV or $M_{e^+e^-} > M_Z + 5$ GeV.
This is to cut out events from Zs, that is, $e^+e^- \to ZZ \to e^+e^-\nu\bar{\nu}$.

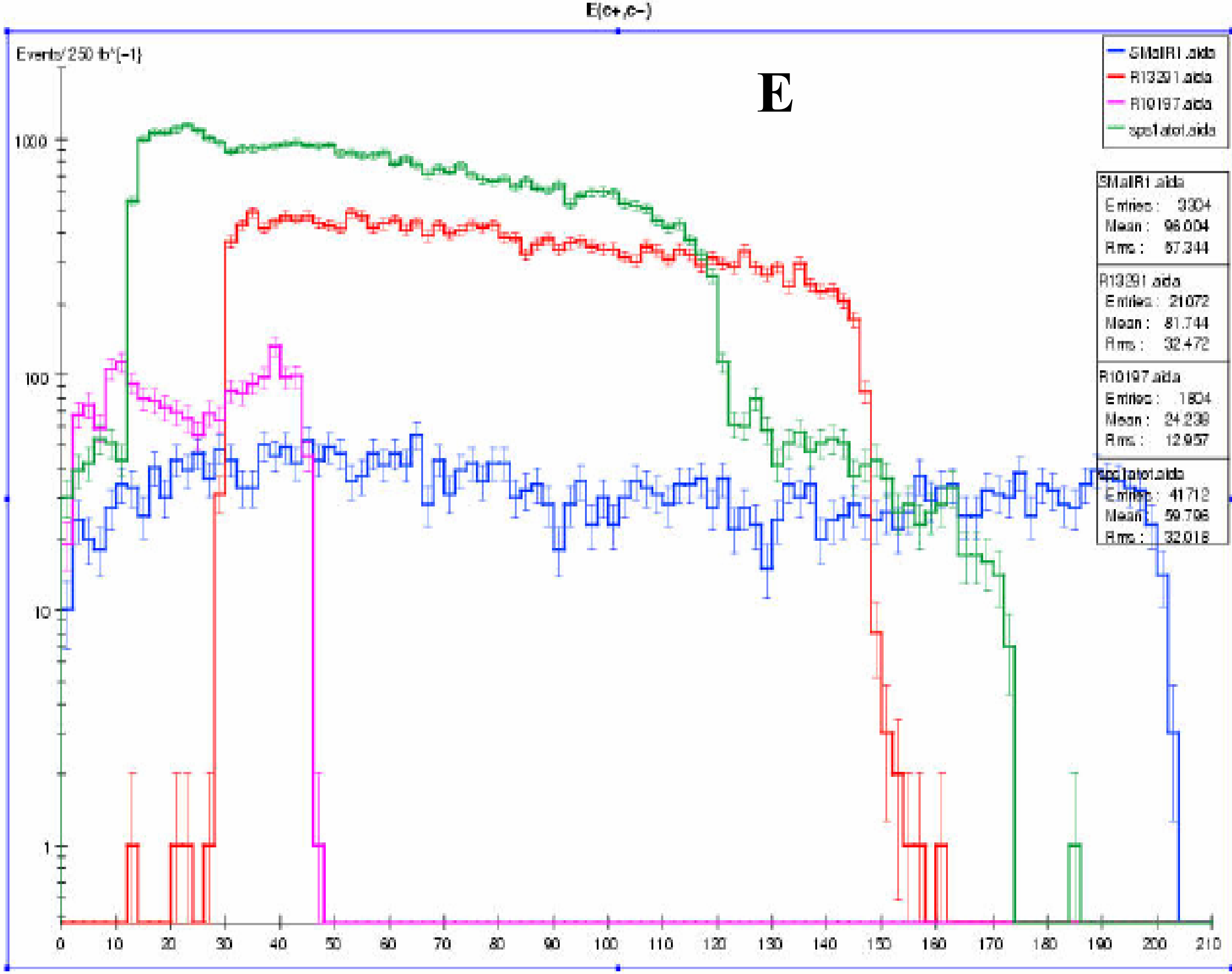


Selectron Example: Good S/B

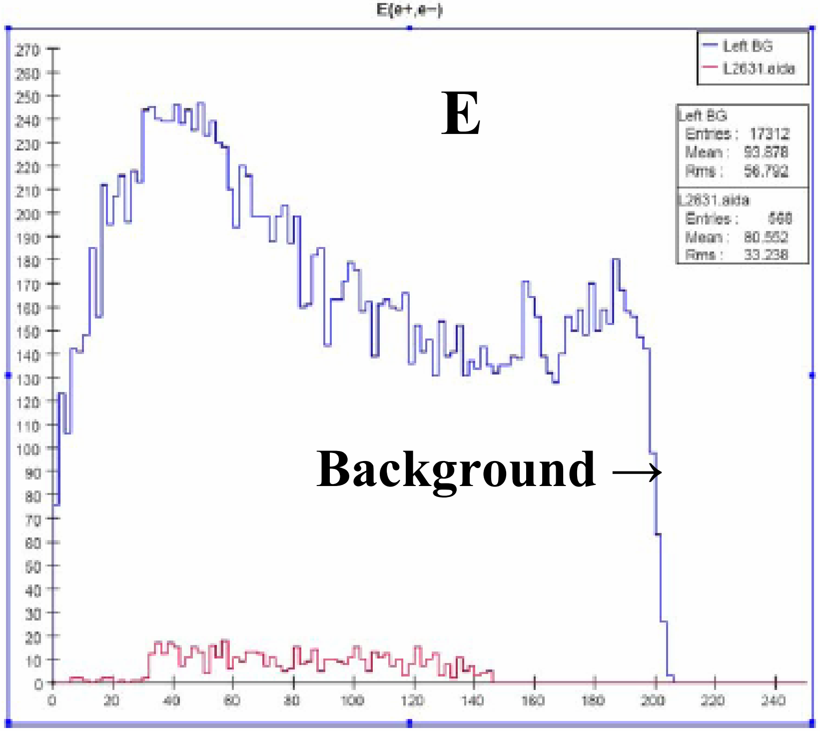
- Model 13291:
- Smuon Masses
  - L: 968.63 GeV
  - R: 187.02 GeV
- LSP Mass: 101.16 GeV

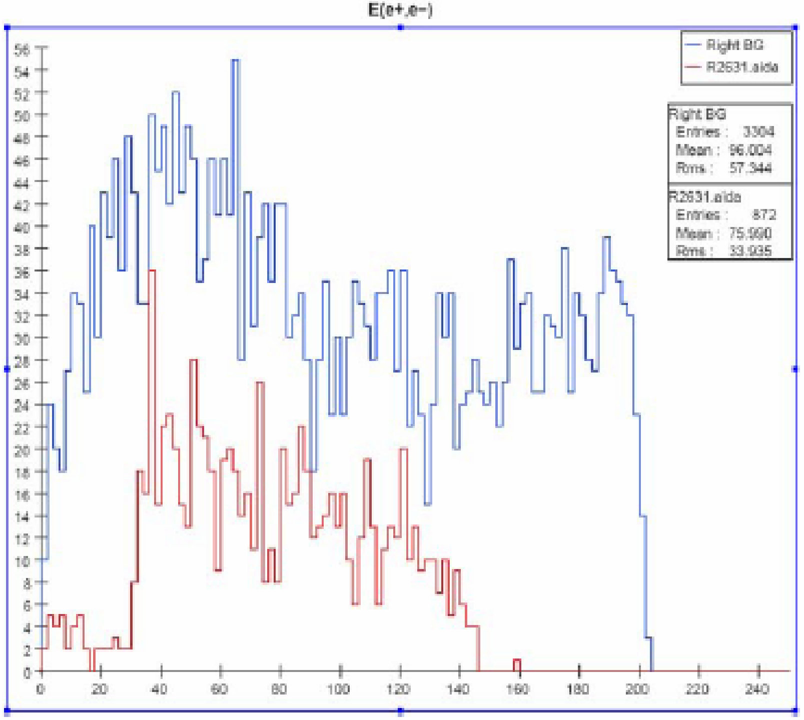
- Model 10197:
- Selectron Masses
  - L: 794.92 GeV
  - R: 170.88 GeV
- LSP Mass: 151.93 GeV

- SPS1A:
- Selectron Masses
  - L: 202.14 GeV
  - R: 142.97 GeV
- LSP Mass: 96.05 GeV



However, sometimes the signal is buried and things are not as





- Selectron signal from model 2631 is totally invisible for left-handed polarization, marginally visible for right-handed polarization

From

Smuon Example: Good S/B

Generally very clean !

- Model 13291:
- Smuon Masses
  - L: 968.63 GeV
  - R: 187.02 GeV
- LSP Mass: 101.16 GeV

- Model 10197:
- Smuon Masses
  - L: 794.92 GeV
  - R: 170.88 GeV
- LSP Mass: 151.93 GeV

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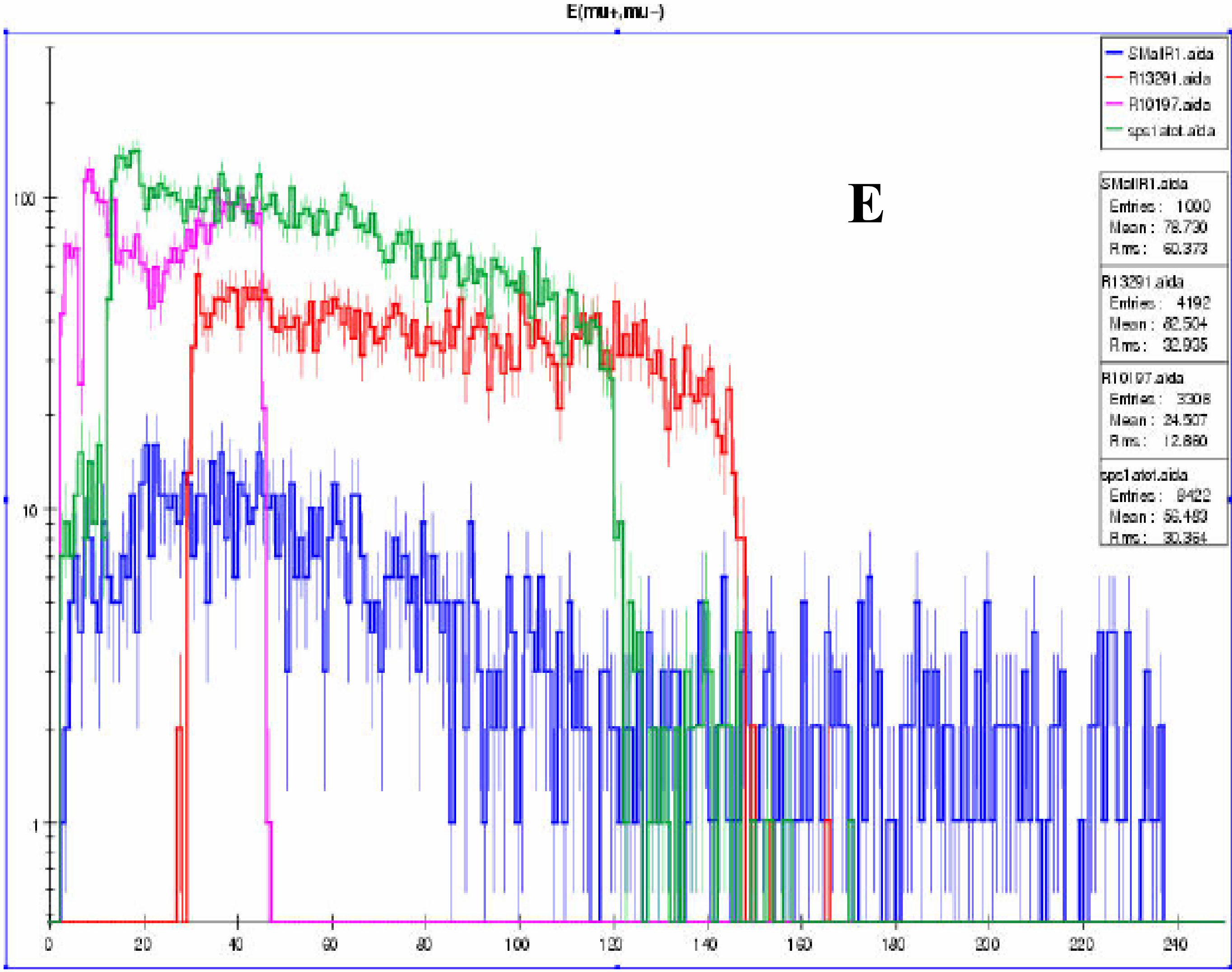
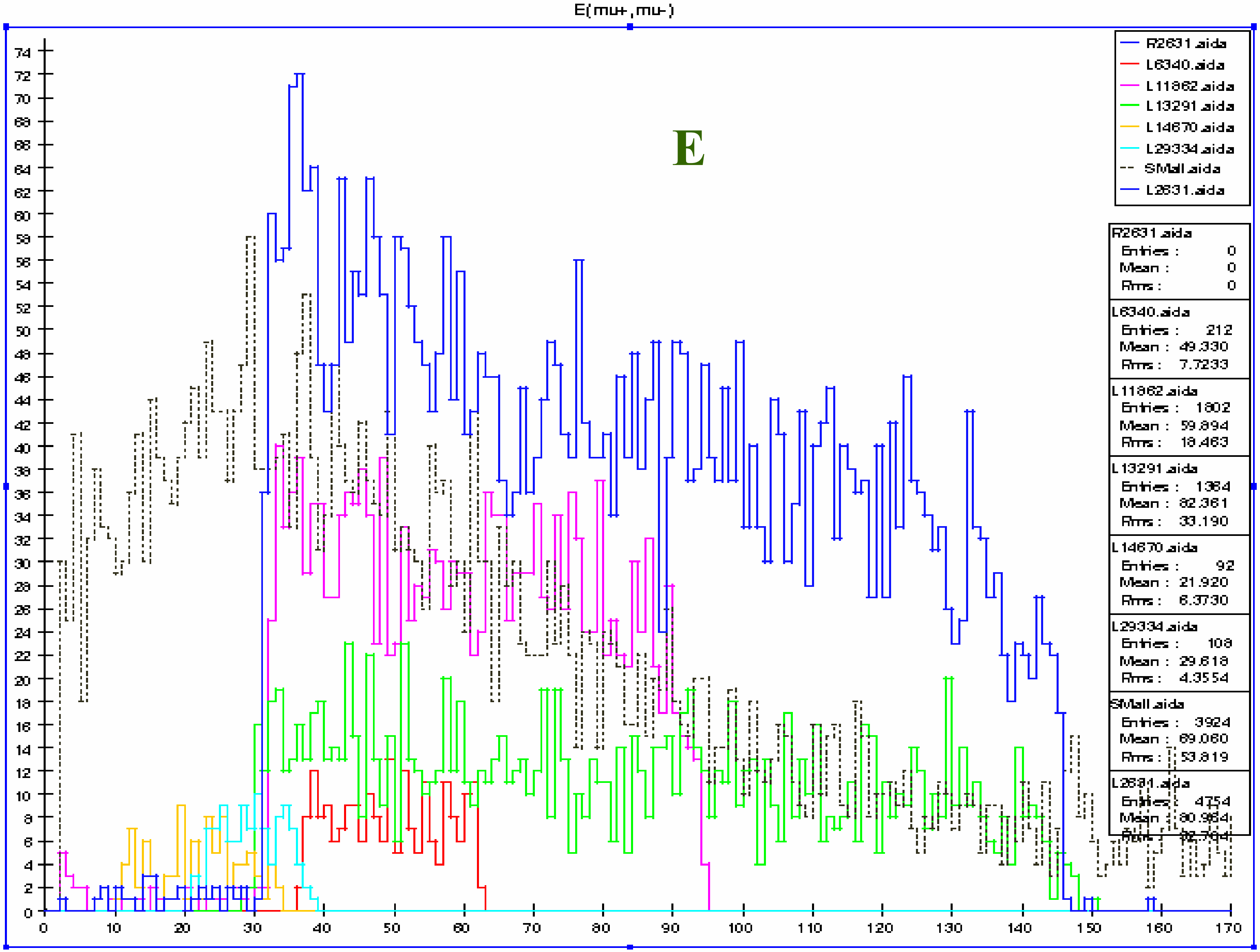


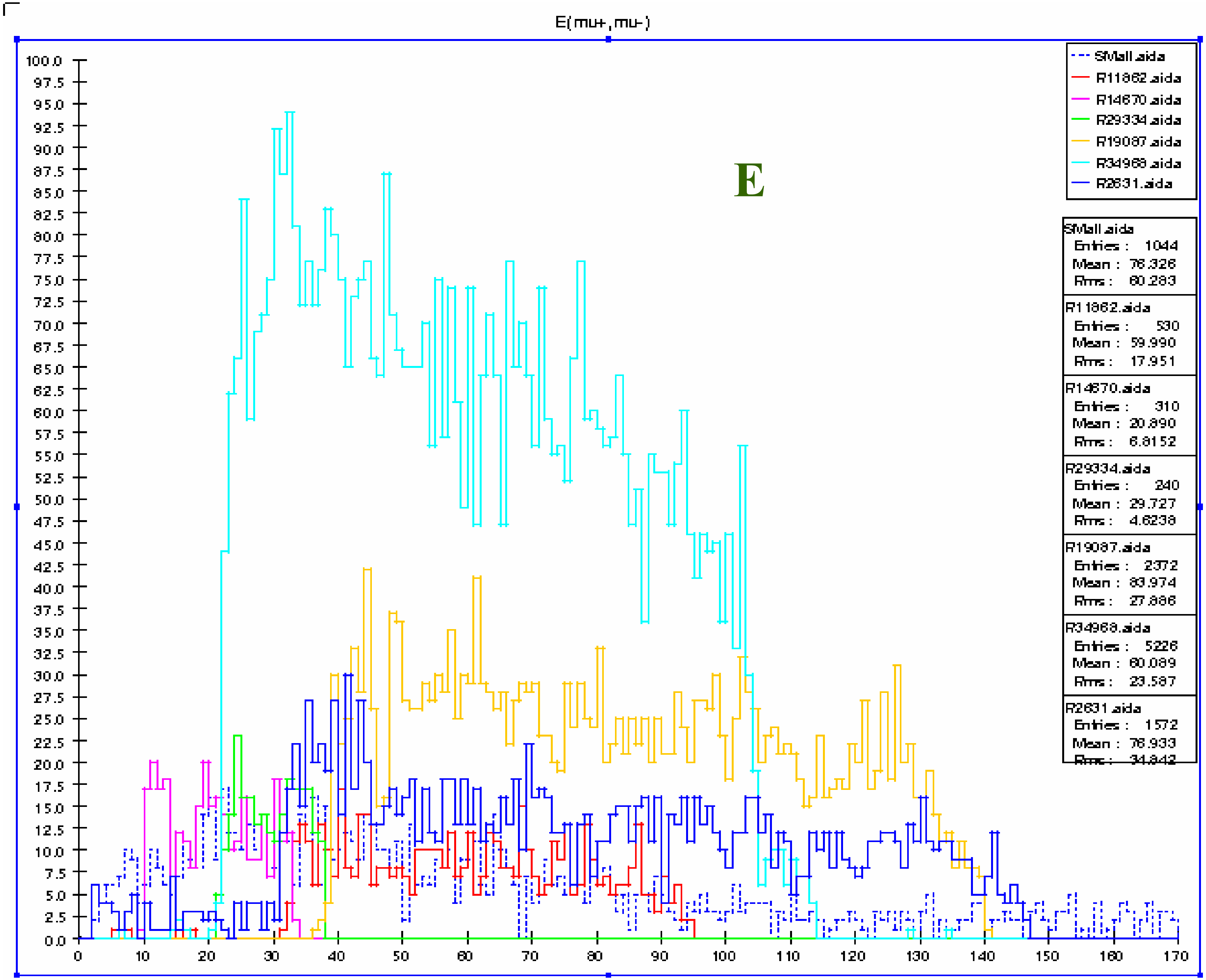
However… some models are more difficult to see…

LH Polarization

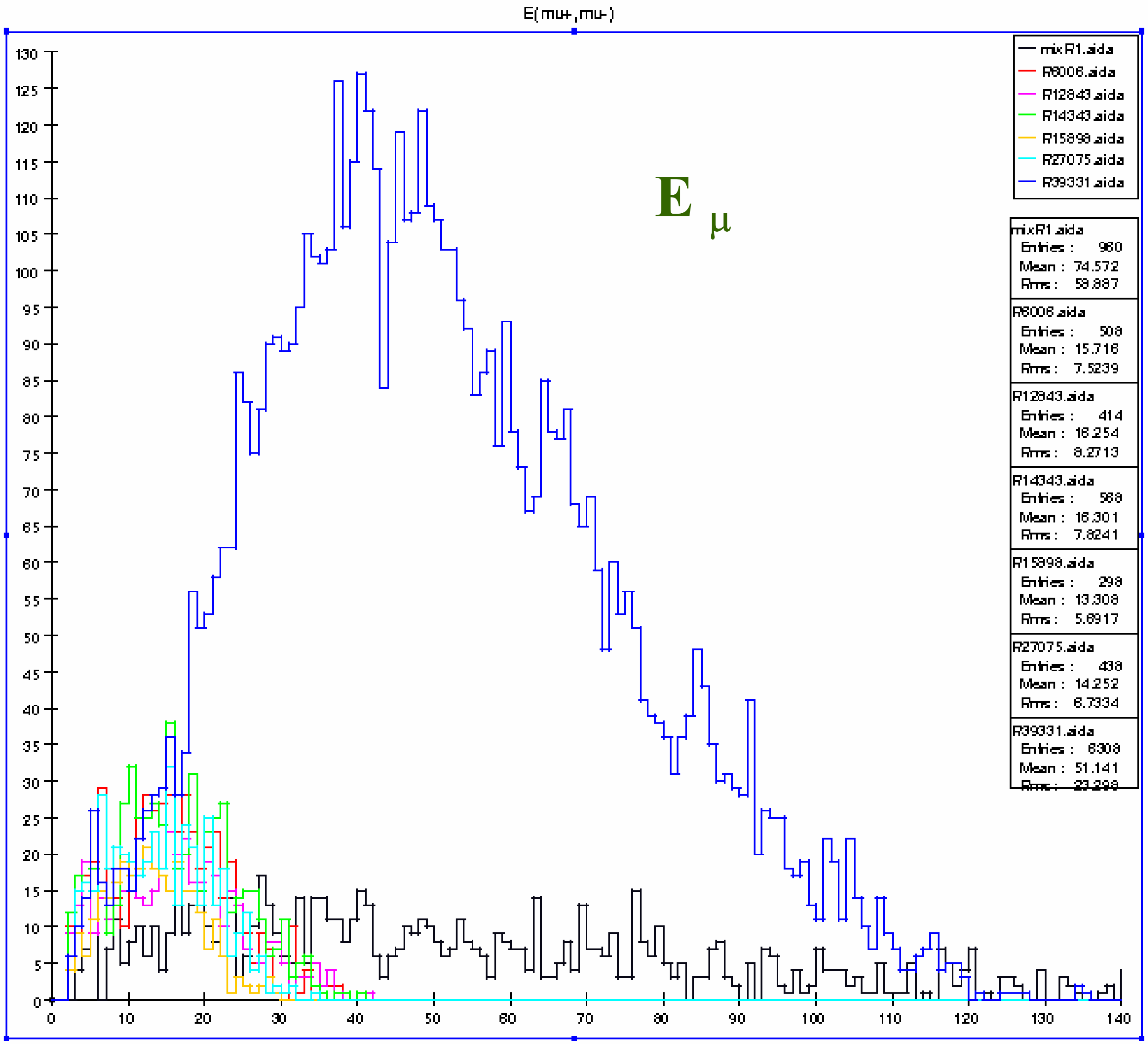


Note the event rates on these plots…..

RH Polarization



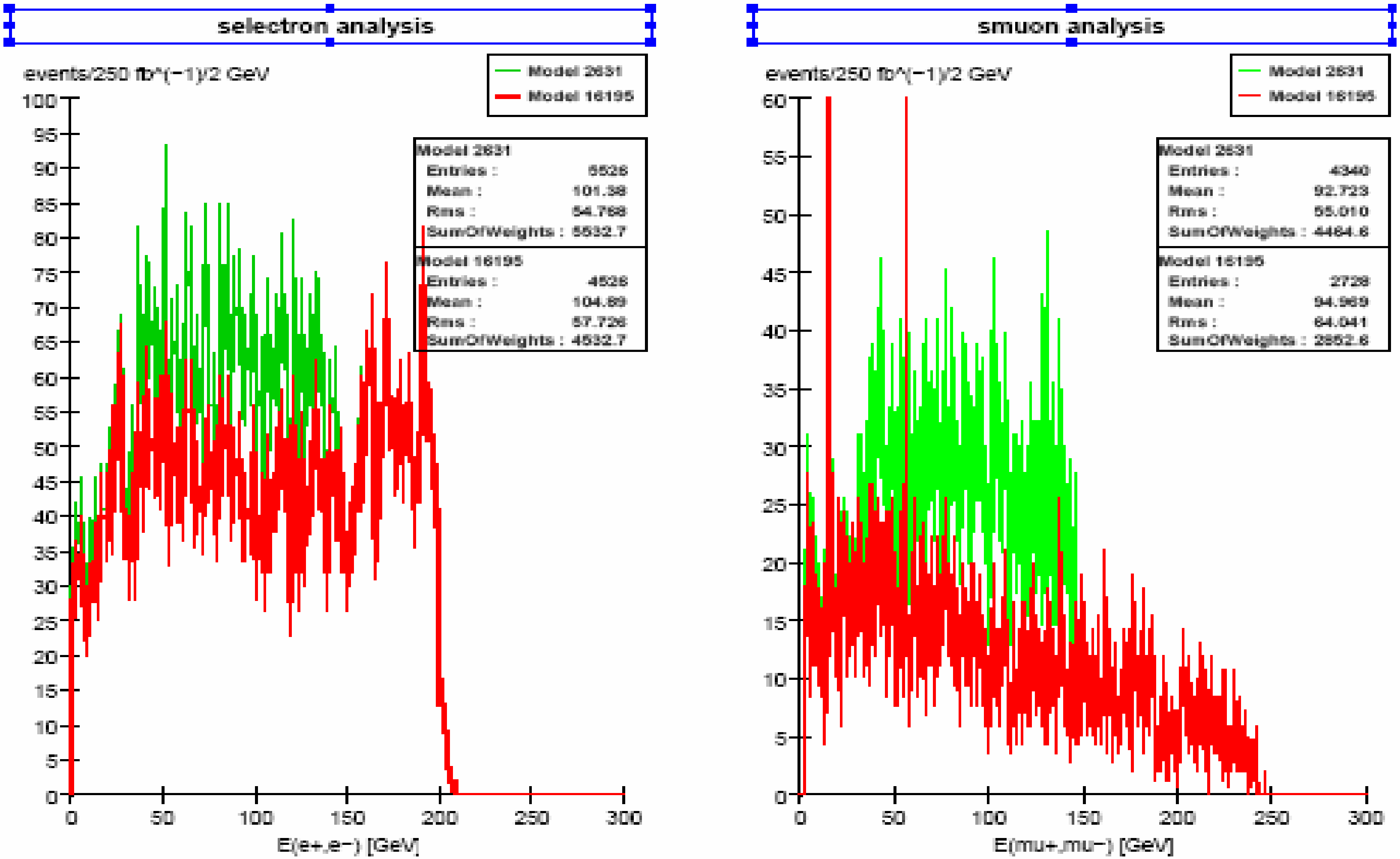
More smuons? Here are 6 models passing the smuon search that are NOT smuons but feed-down from other SUSY particles...



RH

This is a rather common

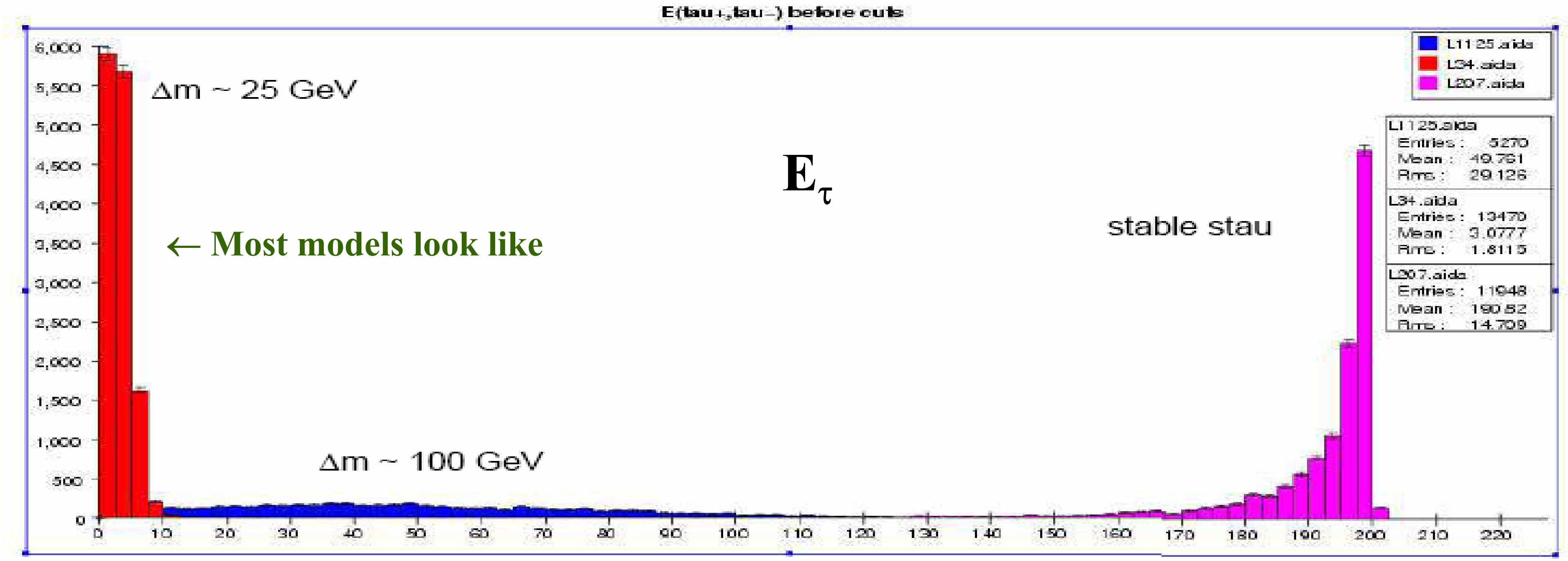
For some slepton cases it is RELATIVELY easy to distinguish models…



Staus are generally much

For large Δm, rates are low while for smaller values the signal is all piled up at low jet energies..which is where the backgrounds are…

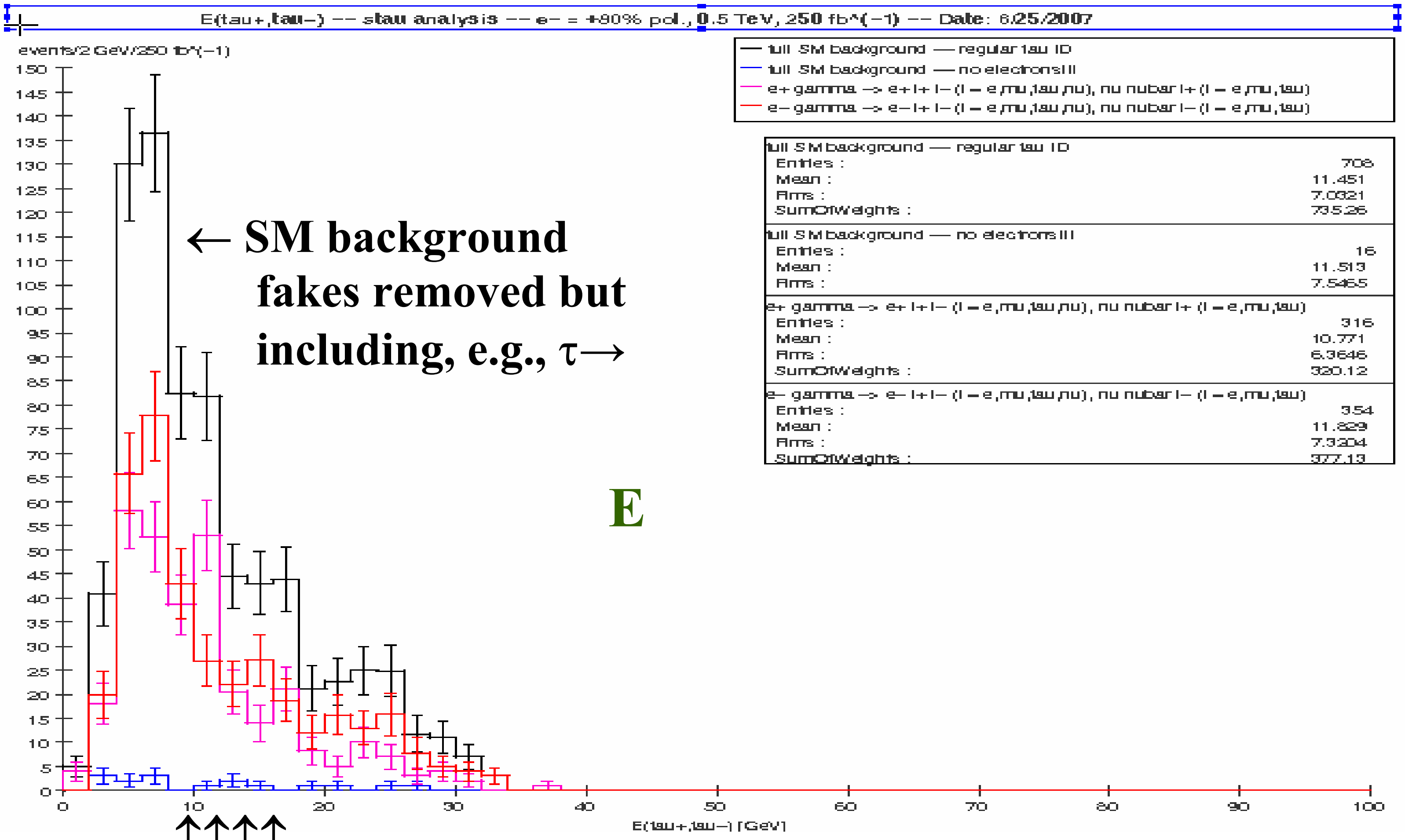
Also in some cases the stau is the lightest MSSM state and is



E_τ

← Most models look like

Stau backgrounds are quite reasonable once one suitable tau ID cuts and removes leptons faking

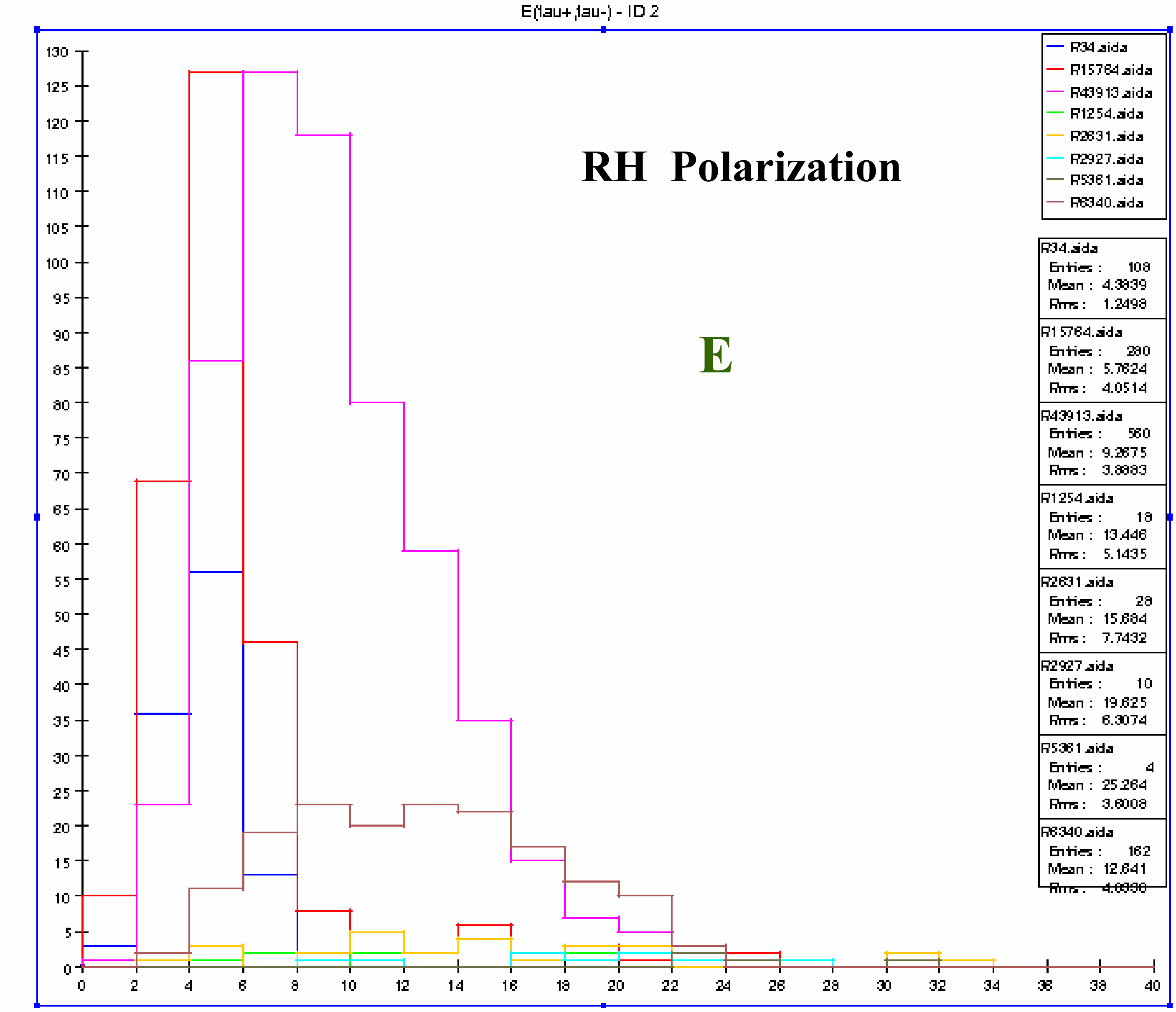


← SM background fakes removed but including, e.g., τ→ E

↑↑↑↑

SM background (after removing events with electrons) !

However, not too many models yield a large enough



RH Polarization

E

♠ Sneutrino pairs are kinematically accessible in 11/242

For the first 2 generations we have :

(*i*) **sneutrino → ν + LSP is invisible, but generally dominates** **X**

(*ii*) **sneutrino → W + slepton → jj + lepton + LSP : not allowed on-shell** **X**

(*iii*) **sneutrino → χ_1^+ + lepton → jj +lepton +LSP : allowed in only 1 model and the resulting jets are rather soft…..** **X**

(*iv*) **sneutrino → ν + χ_2^0 → jj +missing E : allowed only in one model and the jets are again too soft…** **X**

♣ → sneutrinos are not observable at 500 GeV in any

…and tagging the sneutrino final state with a γ doesn't work

LESSON

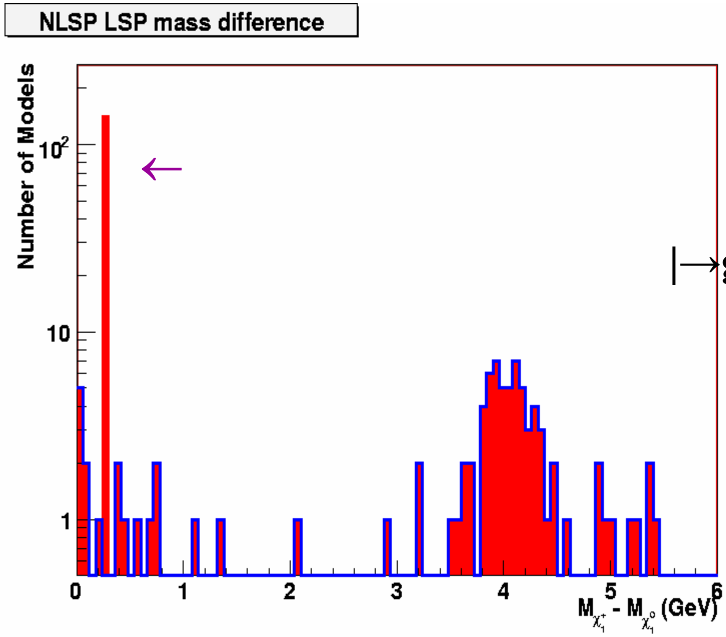
A healthy fraction of the backgrounds in the selectron, stau and, as we'll see, the chargino analyses arises from the lack of tracking/particle ID below ~140 mr in the default description of the SiD detector in the vanilla version of lcsim. Identifying the presence of EM clusters only is no substitute for knowing we have electrons or muons present in the final state at low angles. A user-friendly interface allowing for access to changeable detector parameters would be helpful for physics/detector studies.

It would be helpful for new users if a notice appeared on the webpage describing the coverage and tunable parameters for the downloadable detectors .

Chargino Analyses:

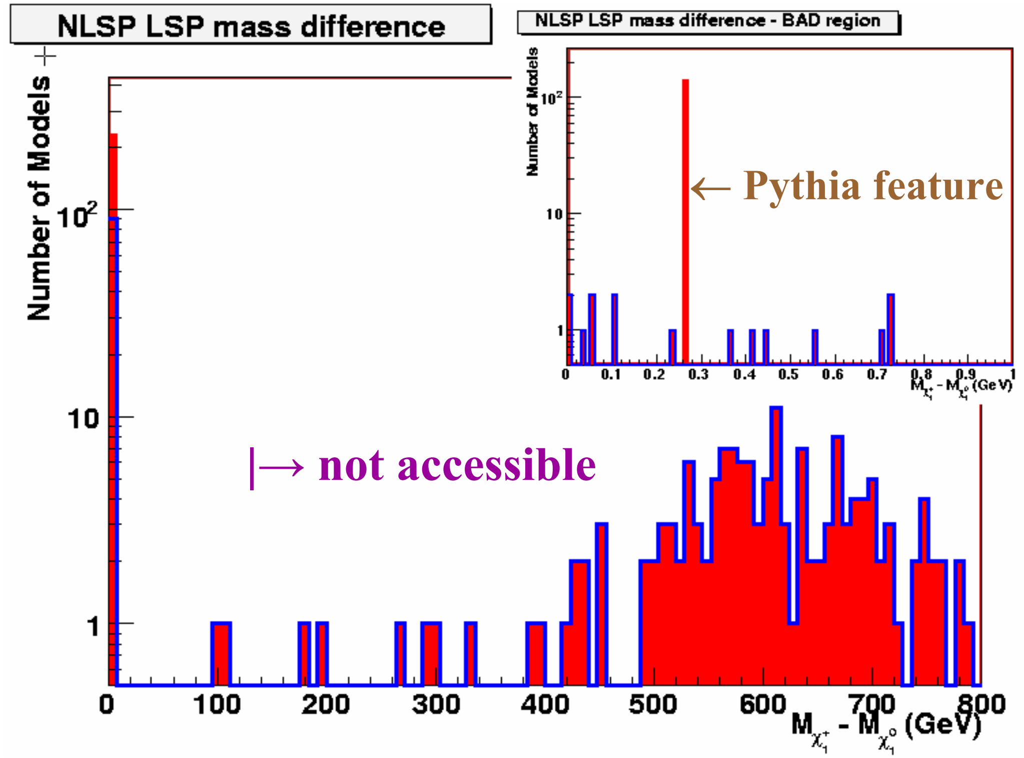
Difficult

Δm is mostly either very small to difficult signatures) or too large (not kinematically accessible).



←

|→gap



← Pythia feature

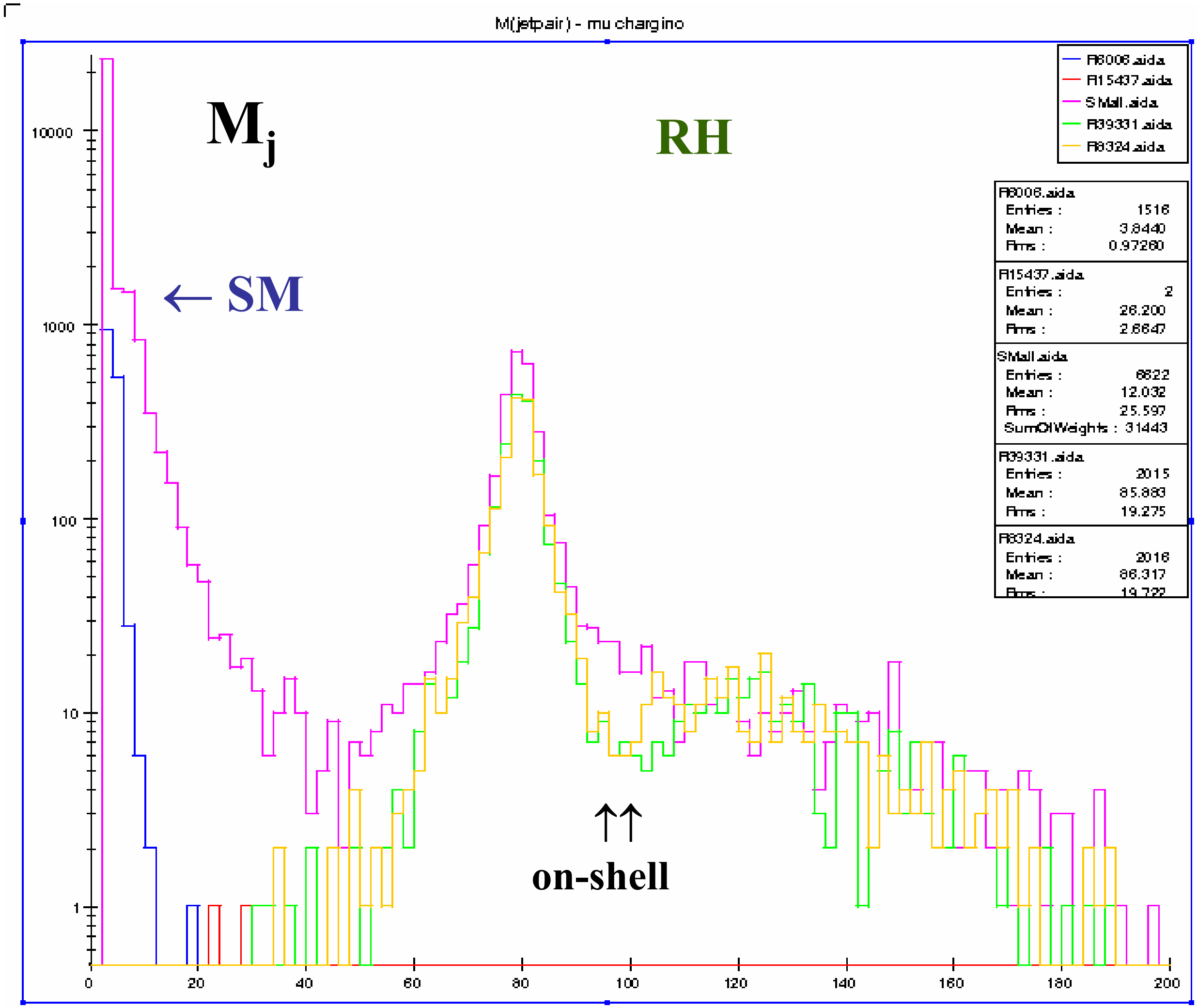
|→ not accessible

↑↑↑↑↑↑↑

Δm clusters in the few GeV mass region which has a lot of serious γγ-induced backgrounds

Charginos-- 2 jet+ muon+missing E Analysis : Dijet Mass

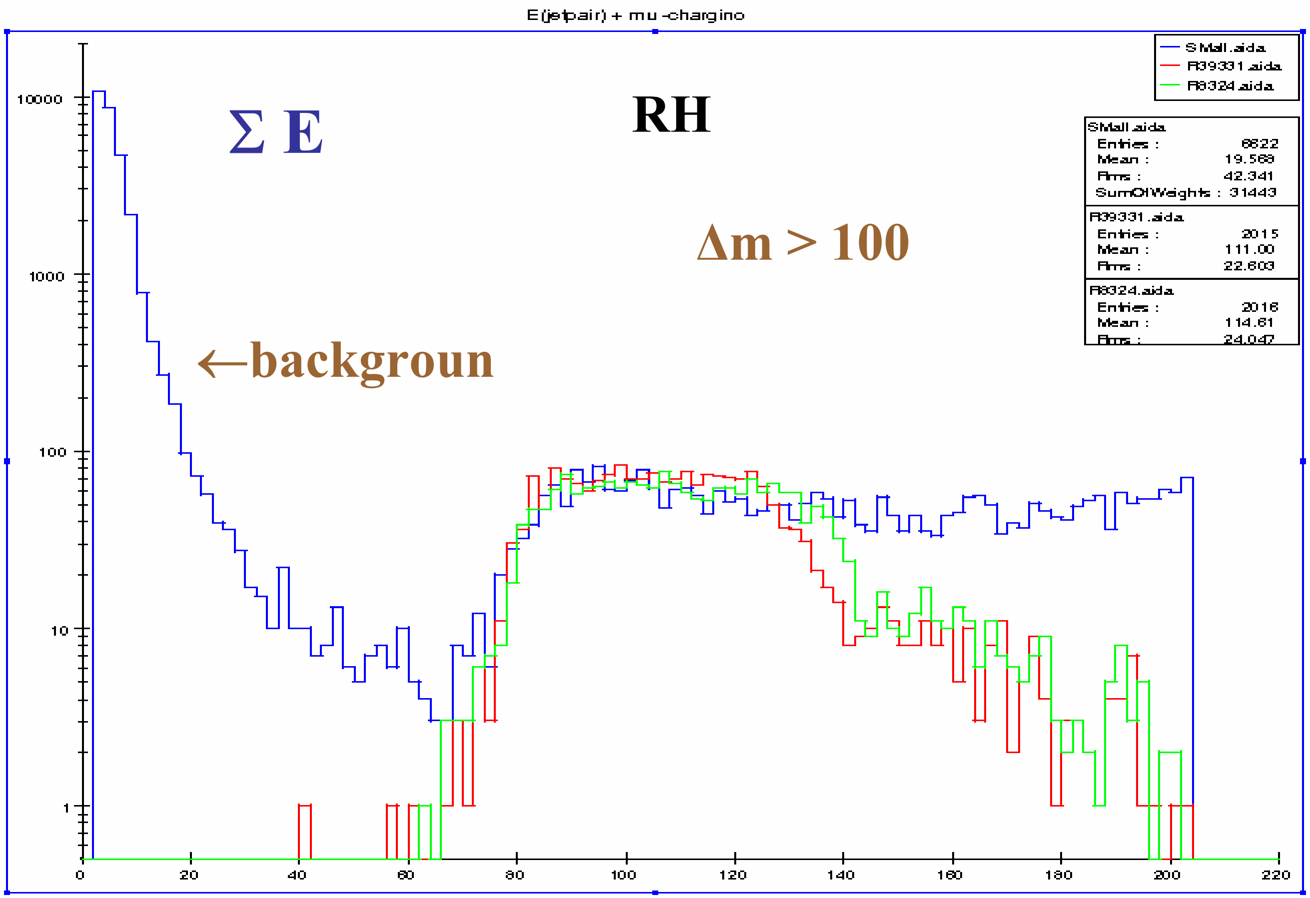
Some of the final state particles are much too soft in many of these models…



…except when $\Delta m > M_W$

Charginos--2 jet+ muon+missing E Analysis : Jet Pair Energy

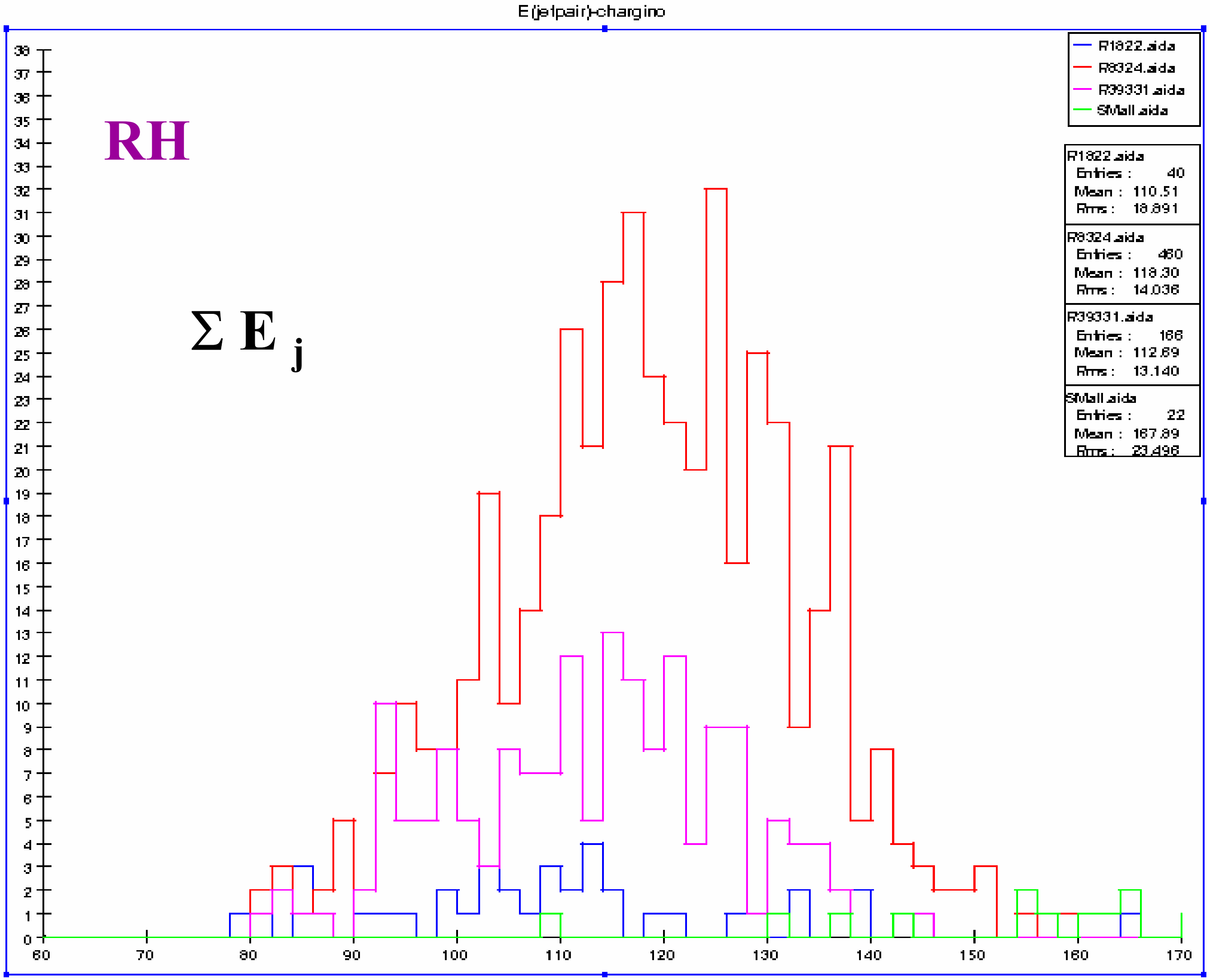
Signals are visible for on-shell W's as Δm is now



These models are rare…

Chargino--4j + missing E analysis : Jet Pair

Again, OK for the on-shell cases..

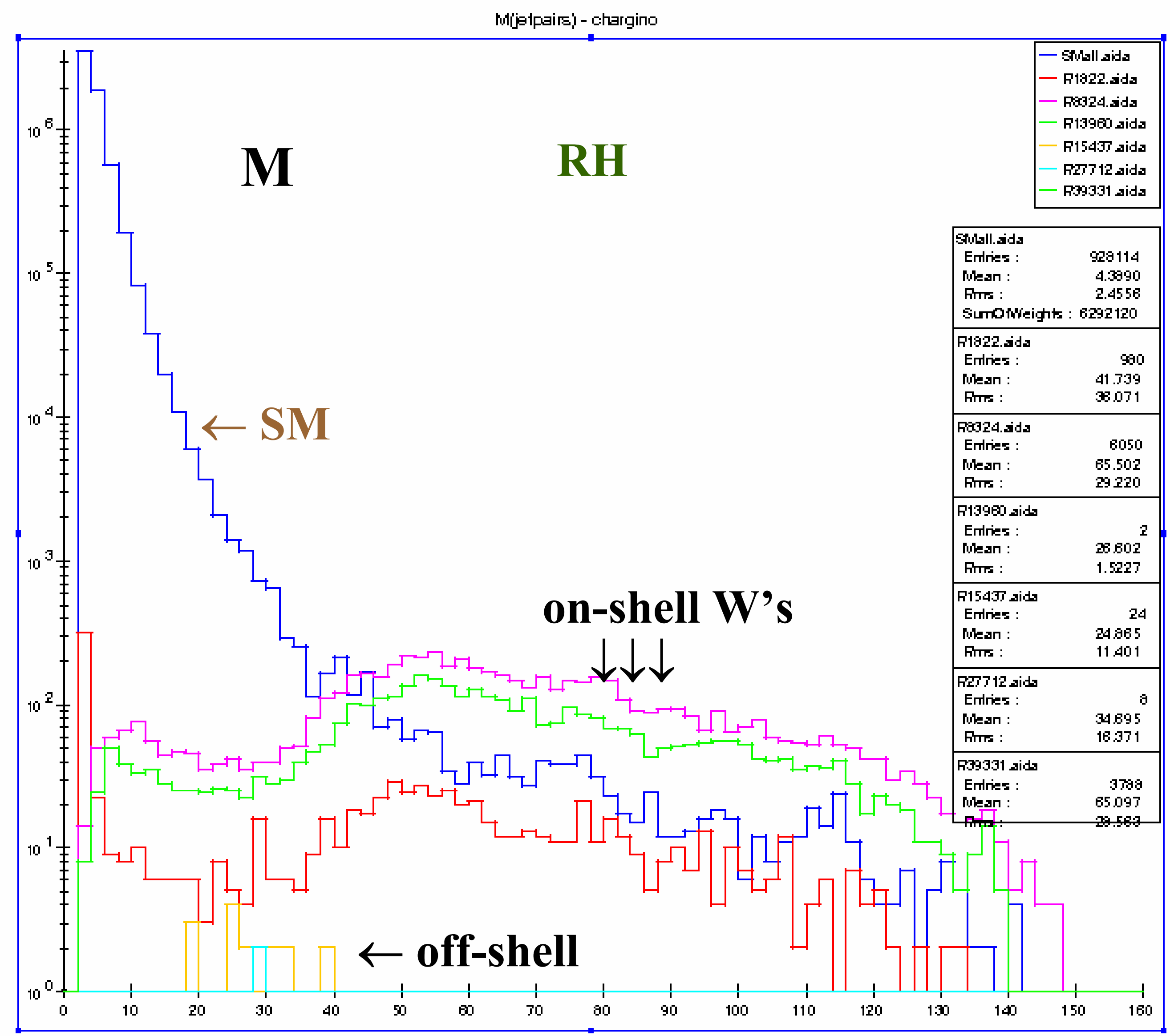


Model 39331
Δm= 103.85 GeV

Model 8324
Δm= 108.23 GeV

Model 1822
Δm=0.133 GeV !!
$2\chi_2^0 \rightarrow 4j+$

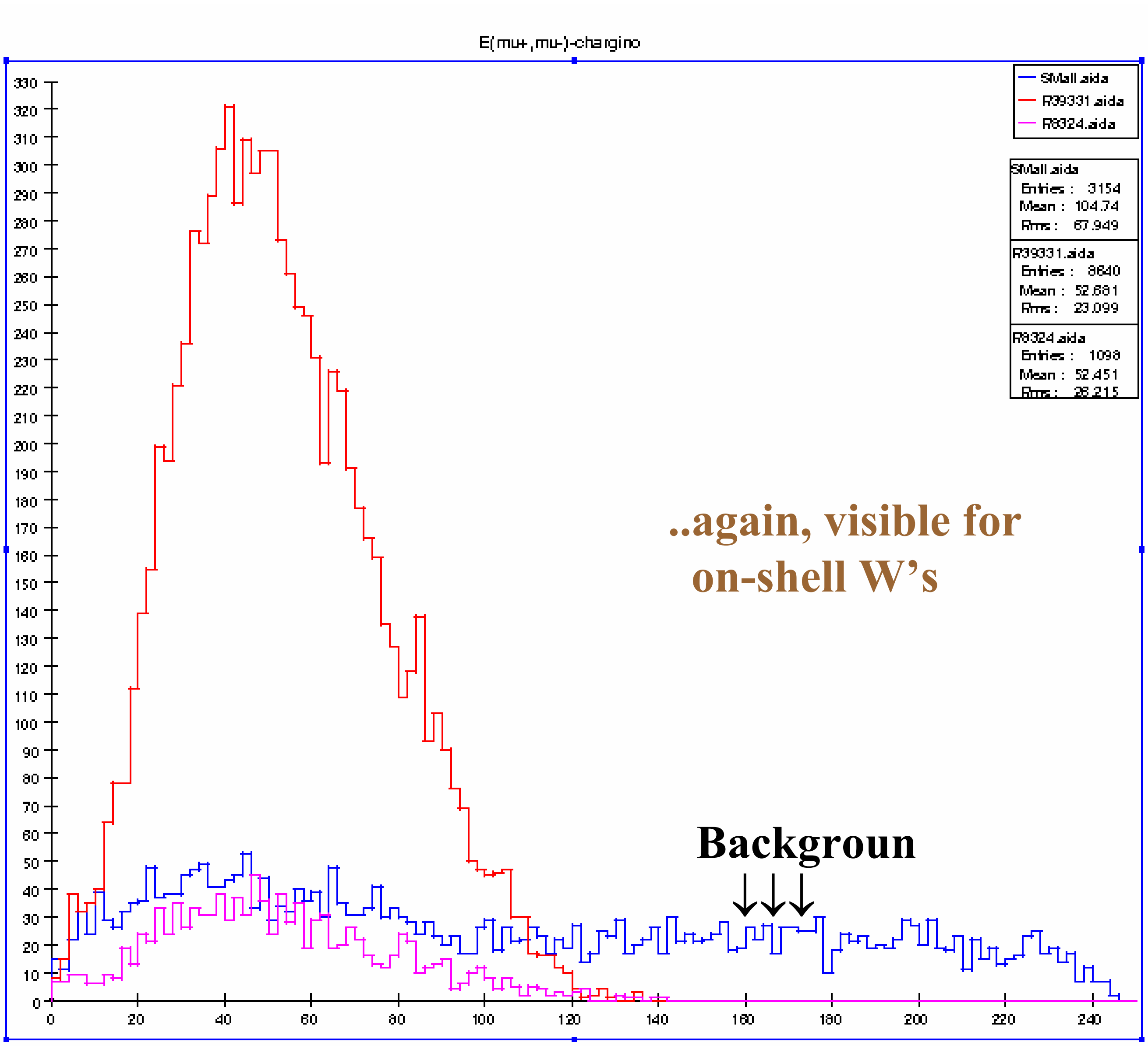
Chargino--4j + missing E analysis : Jet Pair



Again very difficult when off-shell W's are produced ….

Model 1822 again, $2\chi_2^0$ production

Chargino--2μ + missing E analysis : Muon Energy



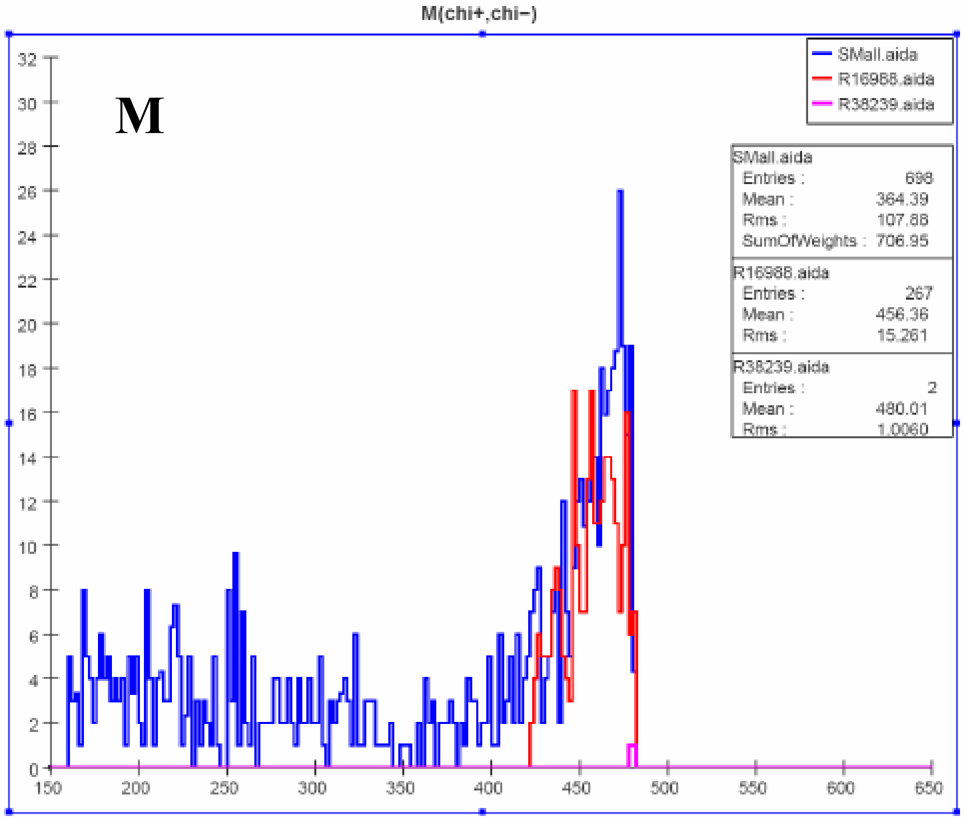
..again, visible for
on-shell W's

Backgroun

↓↓↓

Small Δm ~ Few GeV, Charginos: soft hadrons + photon tag analysis

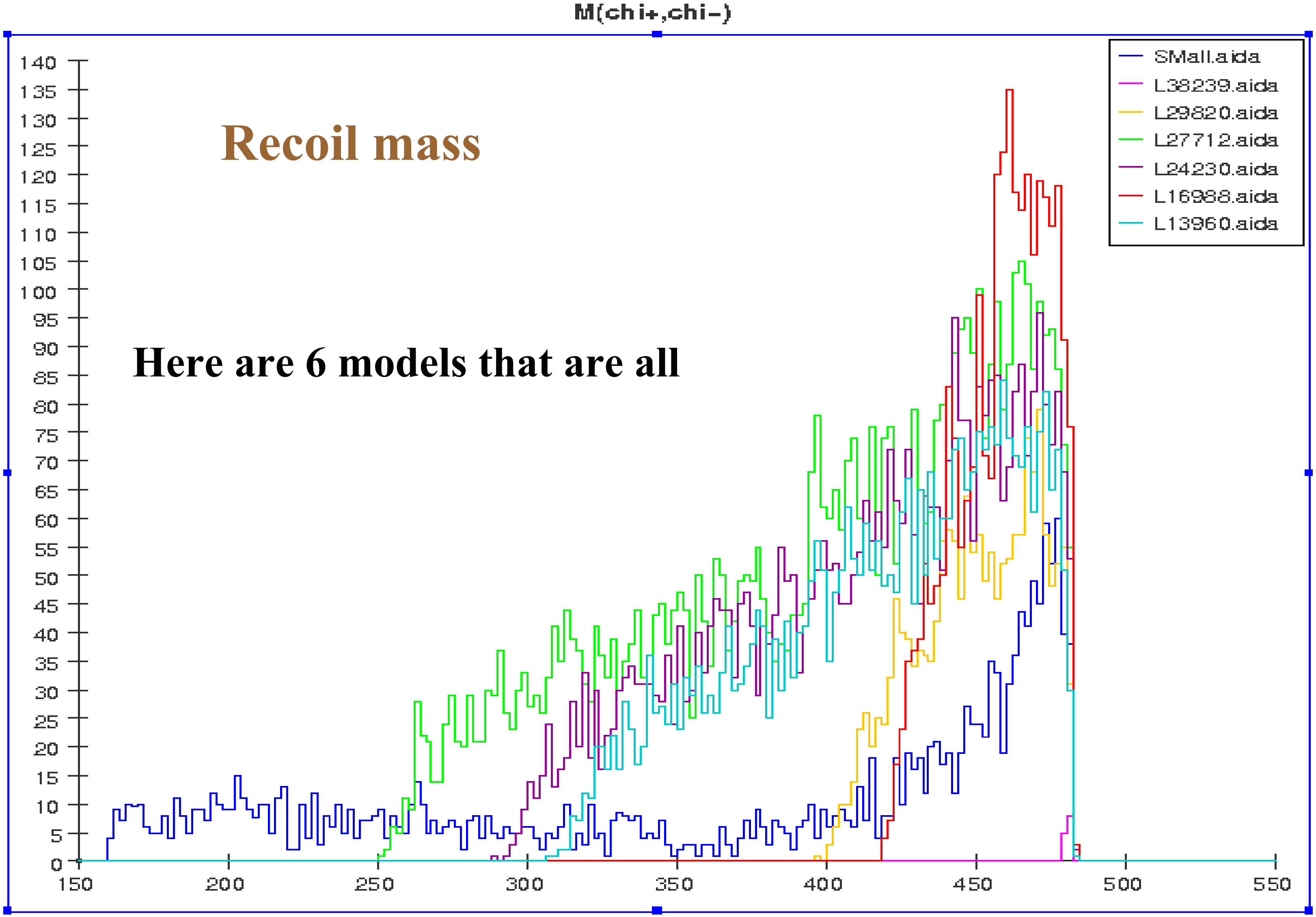
- Model 16988
  Δm = 413 MeV
  LSP mass:
  209.75 MeV
- Model 38239
  Δm = 450 GeV
  LSP mass:
  239.30 GeV
- We can see the signal from model 16988 easily from this analysis
- There is effectively no signal from model 38239 do to the heavier LSP



Signals and background for 80% right-handed electron polarization.

from

Small Δm ~ 1 GeV, Charginos: soft hadrons + photon tag analysis

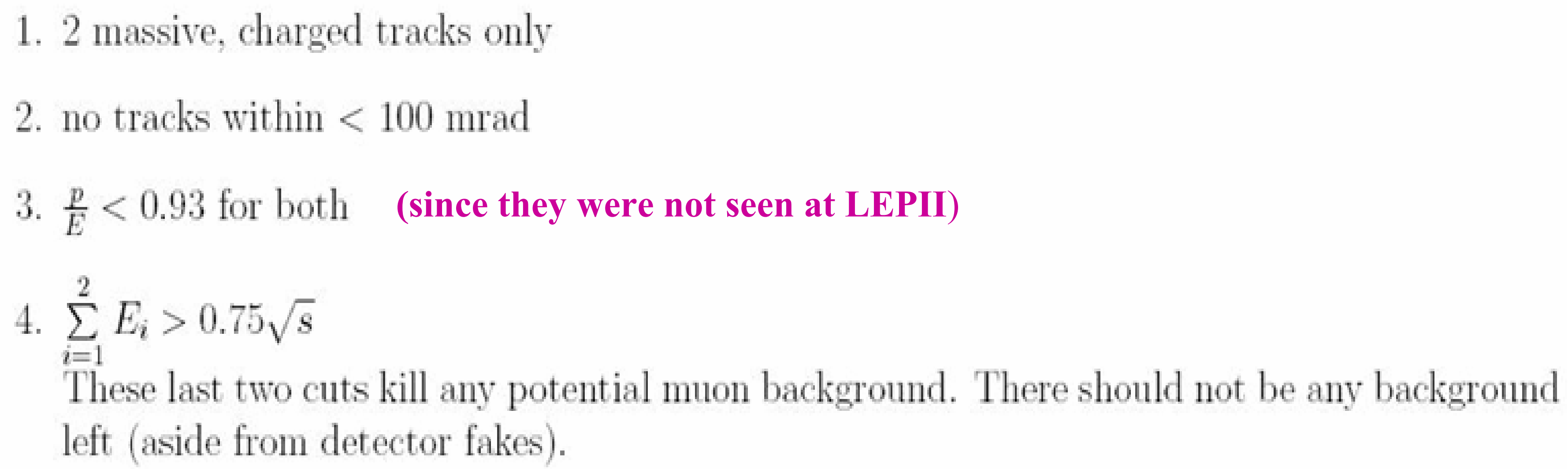


Recoil mass

Here are 6 models that are all

Long-lived Chargino

A surprisingly large number of models have these particles

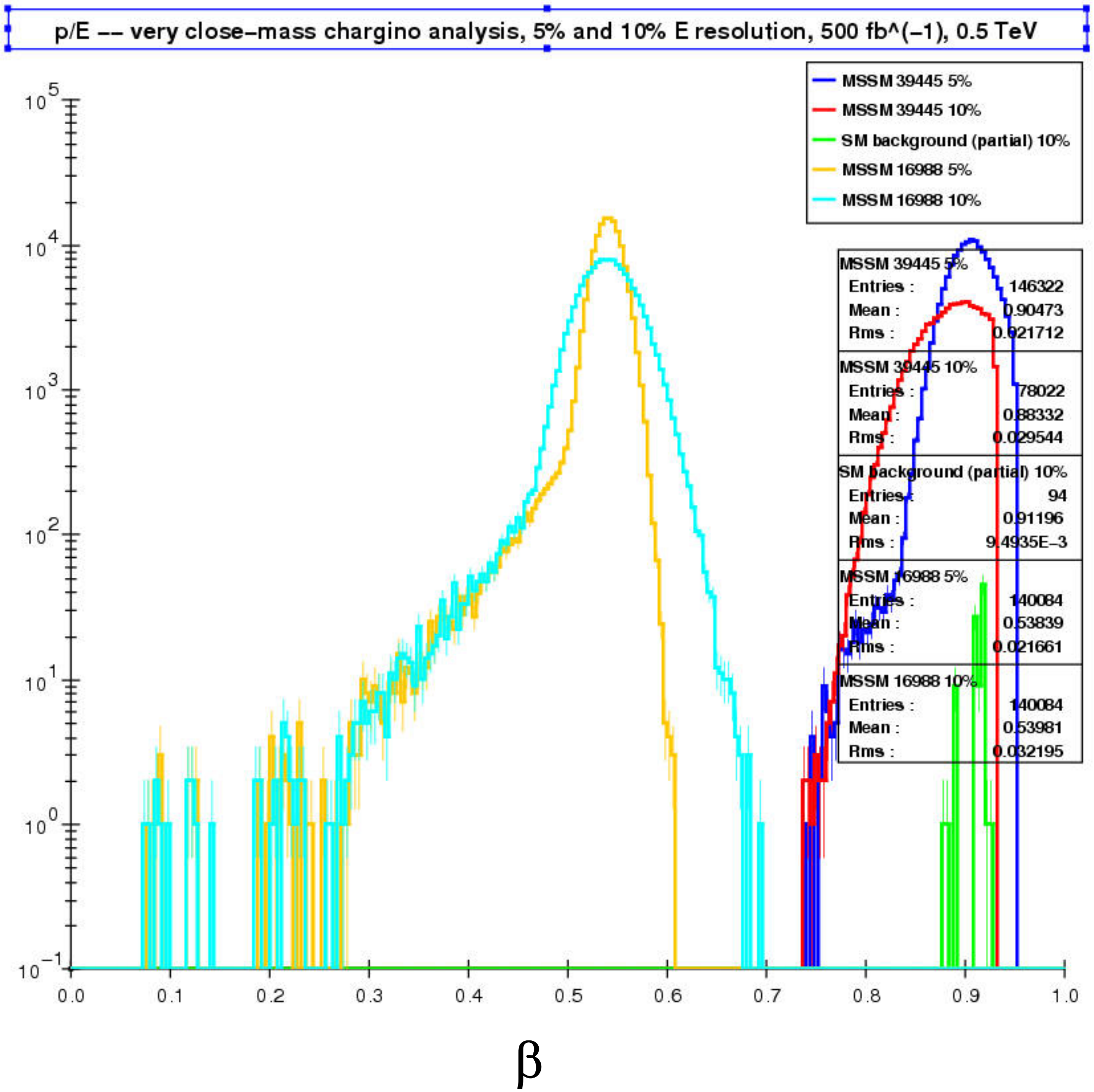


1. 2 massive, charged tracks only
2. no tracks within < 100 mrad
3. $\frac{p}{E} < 0.93$ for both **(since they were not seen at LEPII)**
4. $\sum_{i=1}^{2} E_i > 0.75\sqrt{s}$

These last two cuts kill any potential muon background. There should not be any background left (aside from detector fakes).

β=p/E : p is determined by track curvature in the B field while E is determined by some other method (TOF or dE/dx not yet in vanilla lcsim)…we assume a resolution of δβ=5(10) % in our analysis consistent with ILC detector models. (thanks to B. Schumm)

Background & Signal for Close Mass Case #2

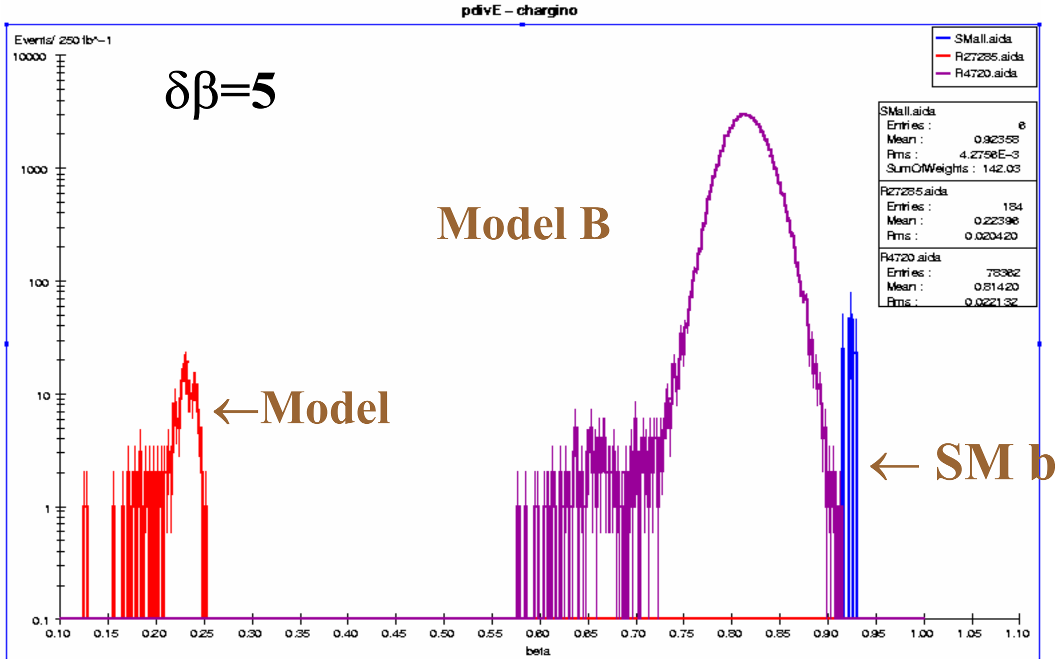


Looks pretty good!

Stable Analysis

From

Stable Particle Searches



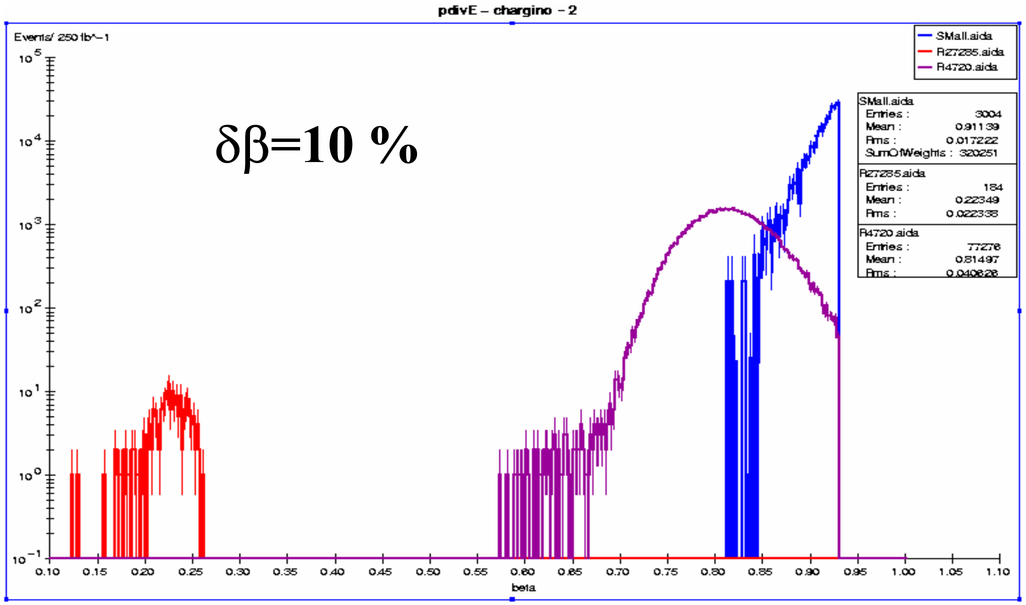
$\delta\beta$=5

Model B

←Model

← SM background

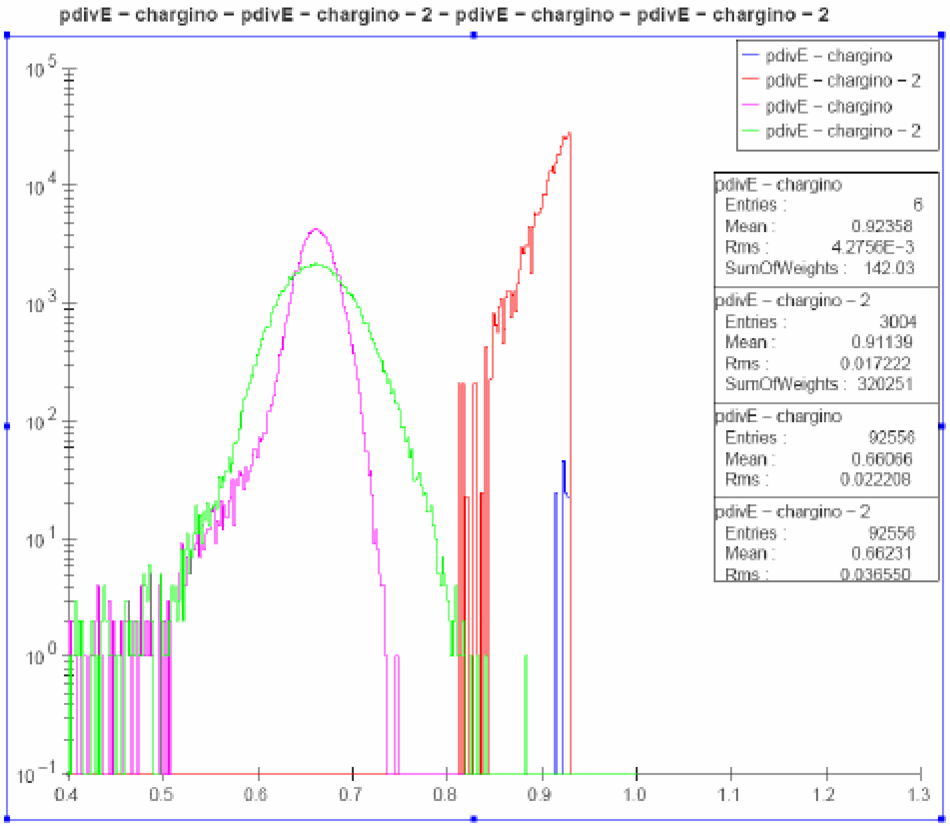
β



$\delta\beta$=10 %

These two models are clearly different for either velocity resolution choices.

Long-lived Chargino Analysis



Signals and background for 80% right-handed electron polarization.

- Model 39445:

  Chargino Mass: 104.92 GeV

  Δm = 1.78 MeV

- Easy discovery, measurement of chargino mass for either energy spread

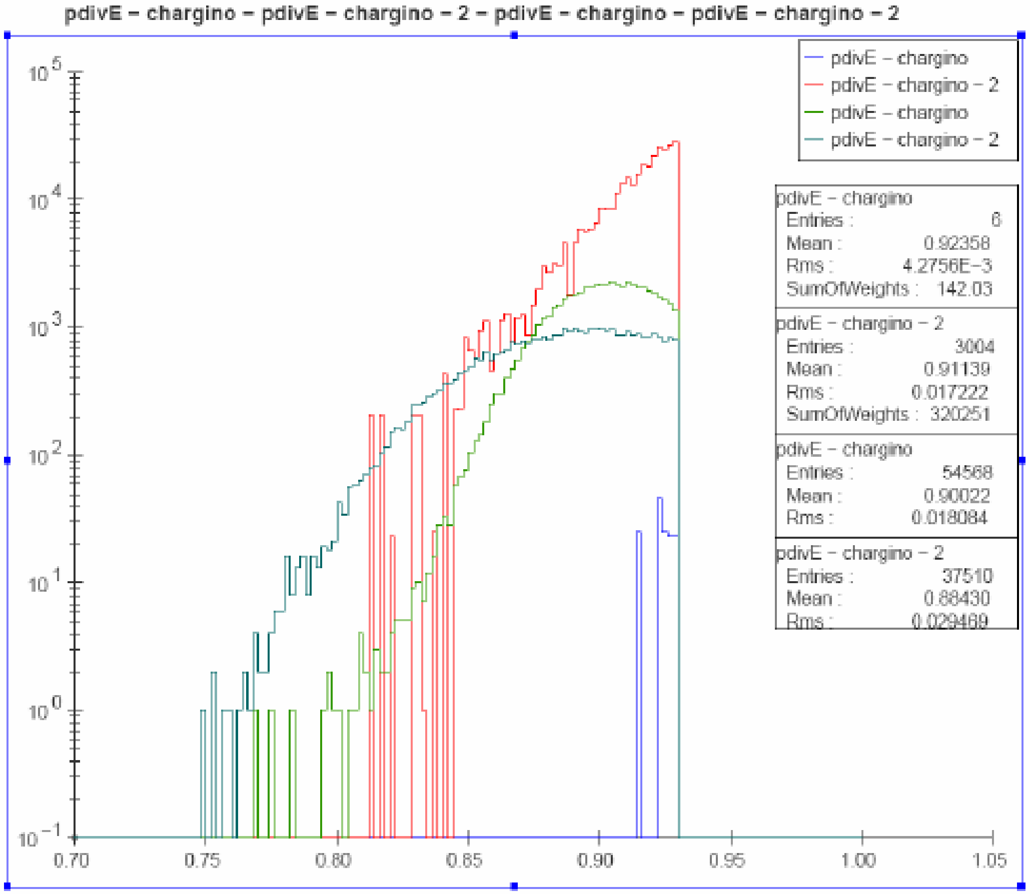
Some are

From

From

Long-lived Chargino Analysis (cont)

..some are a little



pdivE – chargino
Entries : 6
Mean : 0.92358
Rms : 4.2756E–3
SumOfWeights : 142.03

pdivE – chargino – 2
Entries : 3004
Mean : 0.91139
Rms : 0.017222
SumOfWeights : 320251

pdivE – chargino
Entries : 54568
Mean : 0.90022
Rms : 0.018084

pdivE – chargino – 2
Entries : 37510
Mean : 0.88430
Rms : 0.029469

Signals and background for 80% right-handed electron polarization.

- Model 39445:

  Chargino Mass: 104.92 GeV

  Δm = 1.78 MeV

- S/B is huge for 5% smearing, but for 10% smearing the signal is harder to see (though probably visible due to low beta tail).

- Low sensitivity to light chargino masses if energy smearing is 10%

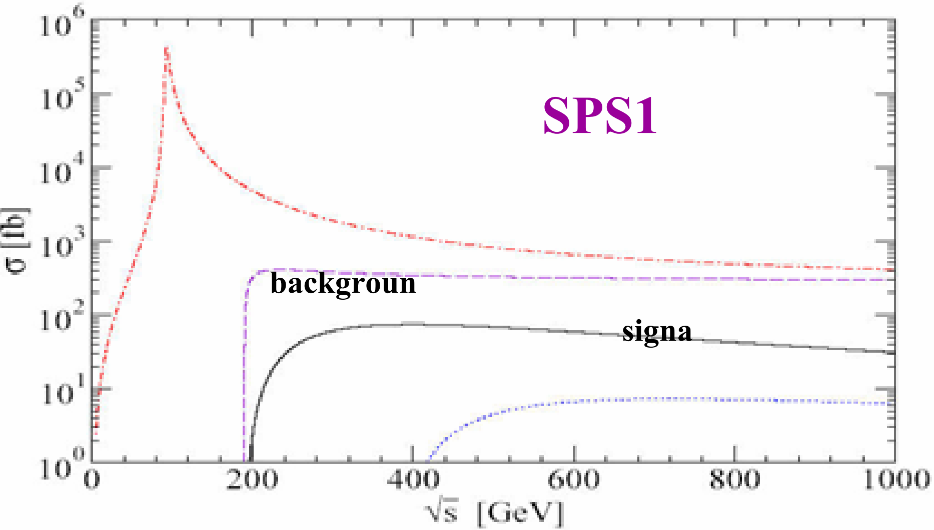
Radiative Neutralino Production

$e^+e^- \to \chi_1^0\chi_1^0$ is *invisible* so we employ the γ-tag again, $e^+e^- \to \chi_1^0\chi_1^0 + \gamma$

which we calculate using **CompHEP**…..

ANALYSIS CUTS AT 500 GeV :

1. One γ and nothing else visible in the event
2. $E_T^\gamma = E^\gamma \sin\theta^\gamma > 0.03\sqrt{s}$, θ^γ is γ angle w/ beam axis
3. $\sin\theta^\gamma > 0.1$
4. $E^\gamma < 160.0$ GeV (removes radiative return to the Z)
5. Use CompHEP to generate hard matrix element



The signal is `big' for SPS1a but this is *so* over the model space we explore… SM backgrounds from $e^+e^- \to \nu\nu\gamma(\gamma)$ are also very large and difficult to kill with standardized cuts

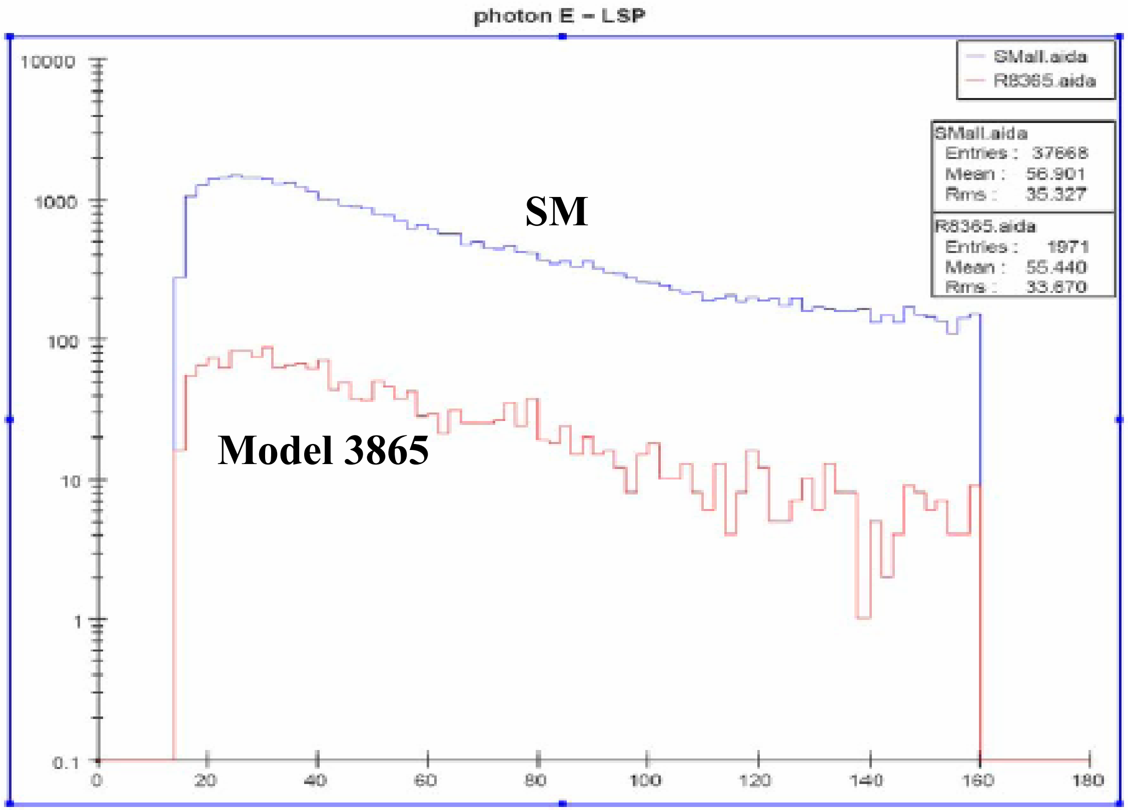
Dreiner et al., hep-ph/0610020

Radiative Neutralino Production

This is a situation where positron polarization would be helpful killing the backgrounds and increasing the signal….

This is the neutralino-only model with the largest signal cross section….

The background here is about 20x larger than the signal so these models look hopeless!!



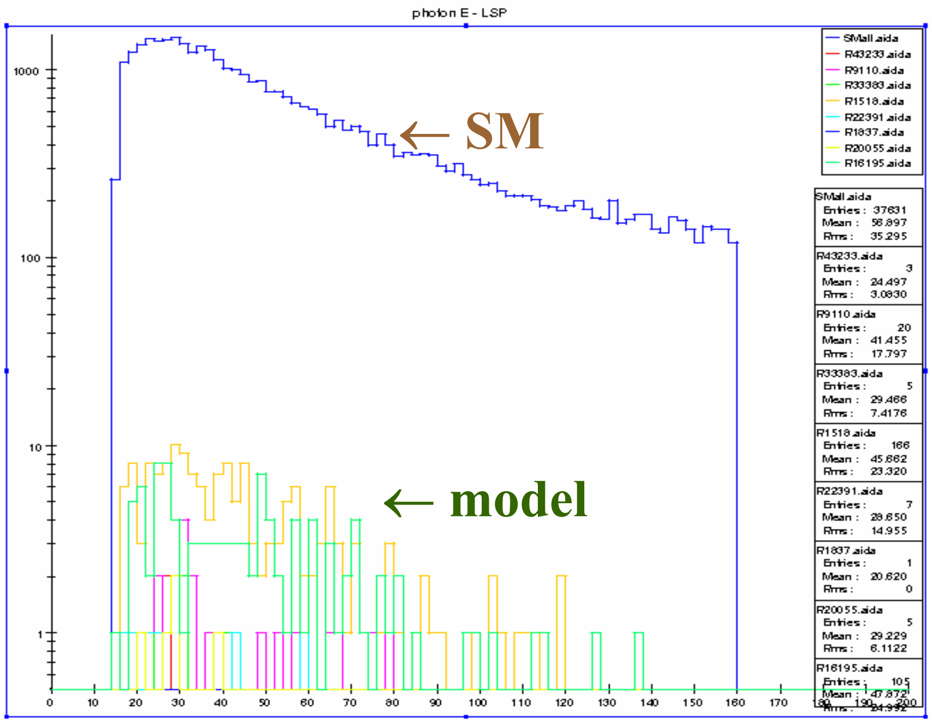
Signal and background for 80% right-handed electron polarization.

....the situation is much worse in all other model

It is clear from this analysis that the LSP-pair final state remains due to the very large SM backgrounds unless we do something

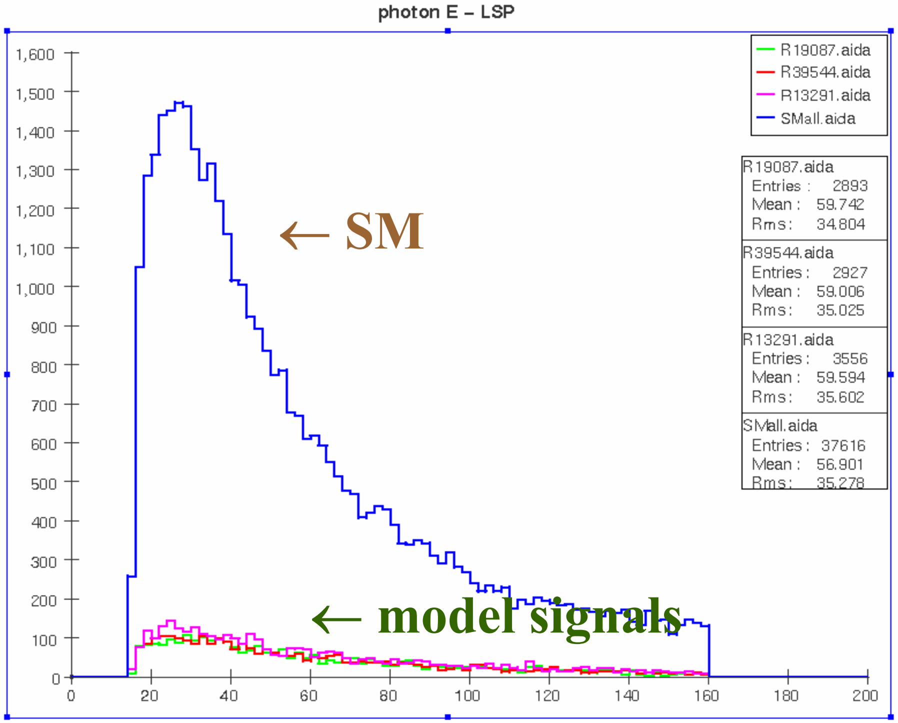
RH Polarization

E $_\gamma$



← SM

← model



← SM

← model signals

The largest contribution to the $e^+e^- \rightarrow \nu\nu\gamma$ background is from graphs with W-exchange coupling to a LH e^- , but this shows a strong polarization dependence, $\sigma^B(e^-_L)$ ~50 $\sigma^B(e^-_R)$….

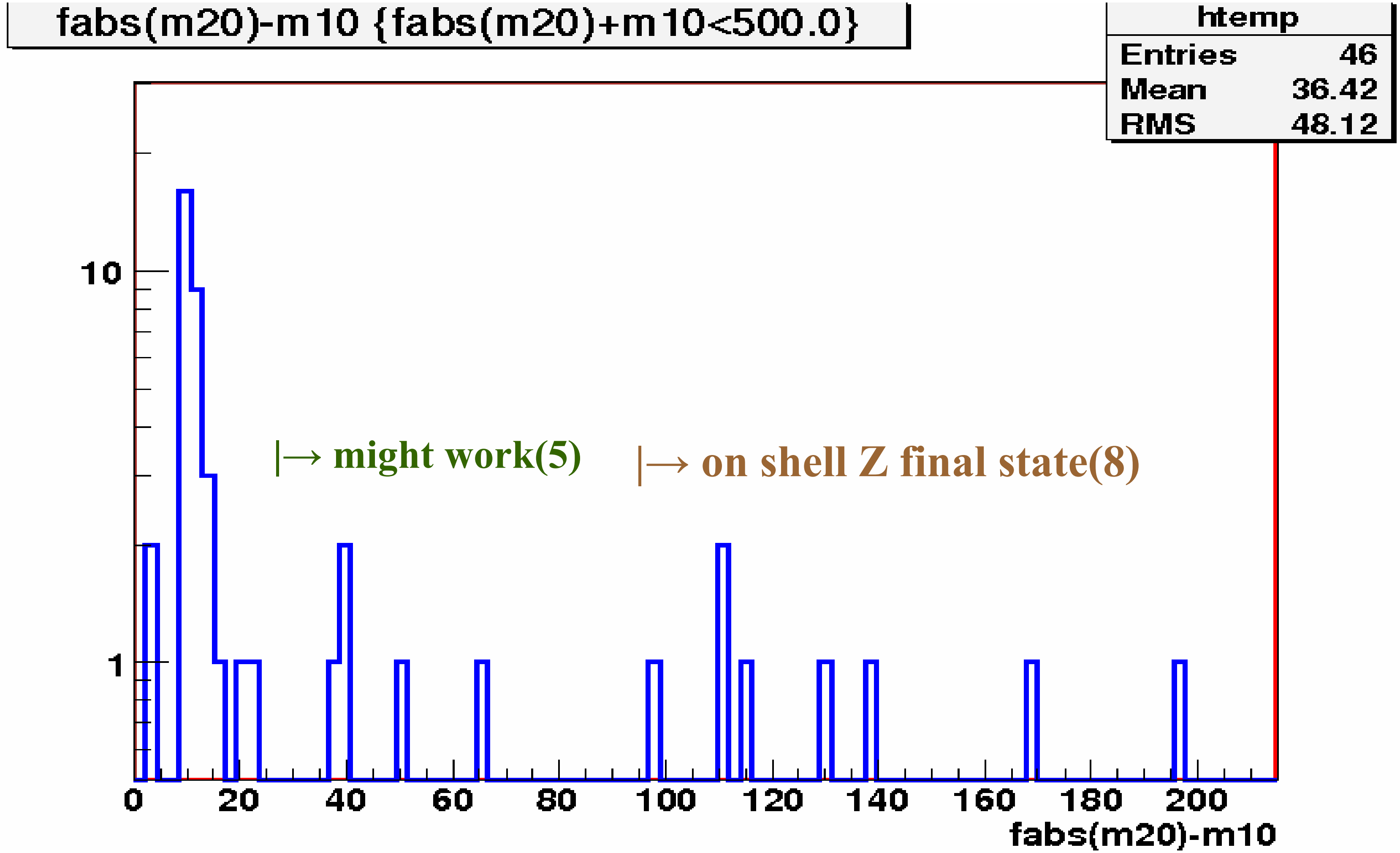
The best way to remove this background is with RH beam polarization and having both beams polarized is even *better* . For the signal, the models cluster with either *(i)* $\sigma^S_L \sim \sigma^S_R$ or *(ii)* $\sigma^S_R >> \sigma^S_L$ This provides another reason to have positron polarization . (hep-ph/0507011)

What does beam polarization (P_-=0.8 +?) do compared to unpolarized beams?

P_+	S_i	S_{ii}	B	S_i /B	S_{ii}/B
0.0	1	1.8	0.2	5.0	8.0
0.30	1.24	2.34	0.14	8.9	16.7
0.45	1.36	2.61	0.11	12.4	23.7
0.60	1.48	2.88	0.08	18.5	36.0

$\chi_2^0\ \chi_1^0$ Analysis :

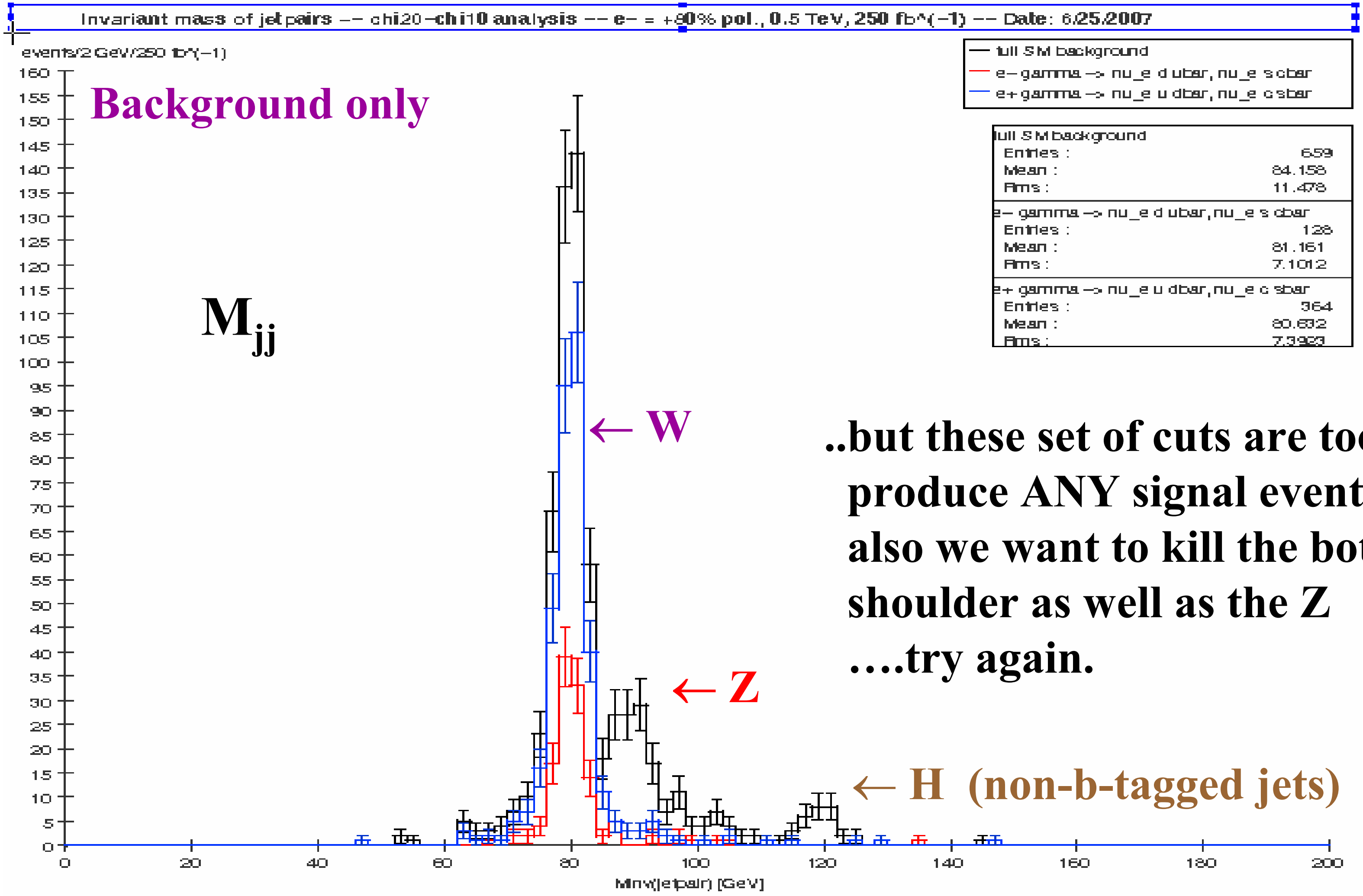
most models accessible at 500 GeV have
a smallish mass splitting and will be tough…



|→ might work(5)

|→ on shell Z final state(8)

$\chi_2^0 \chi_1^0 \rightarrow$ jj + Missing E Analysis : Backgrounds are large…



Background only

M_{jj}

← W

← Z

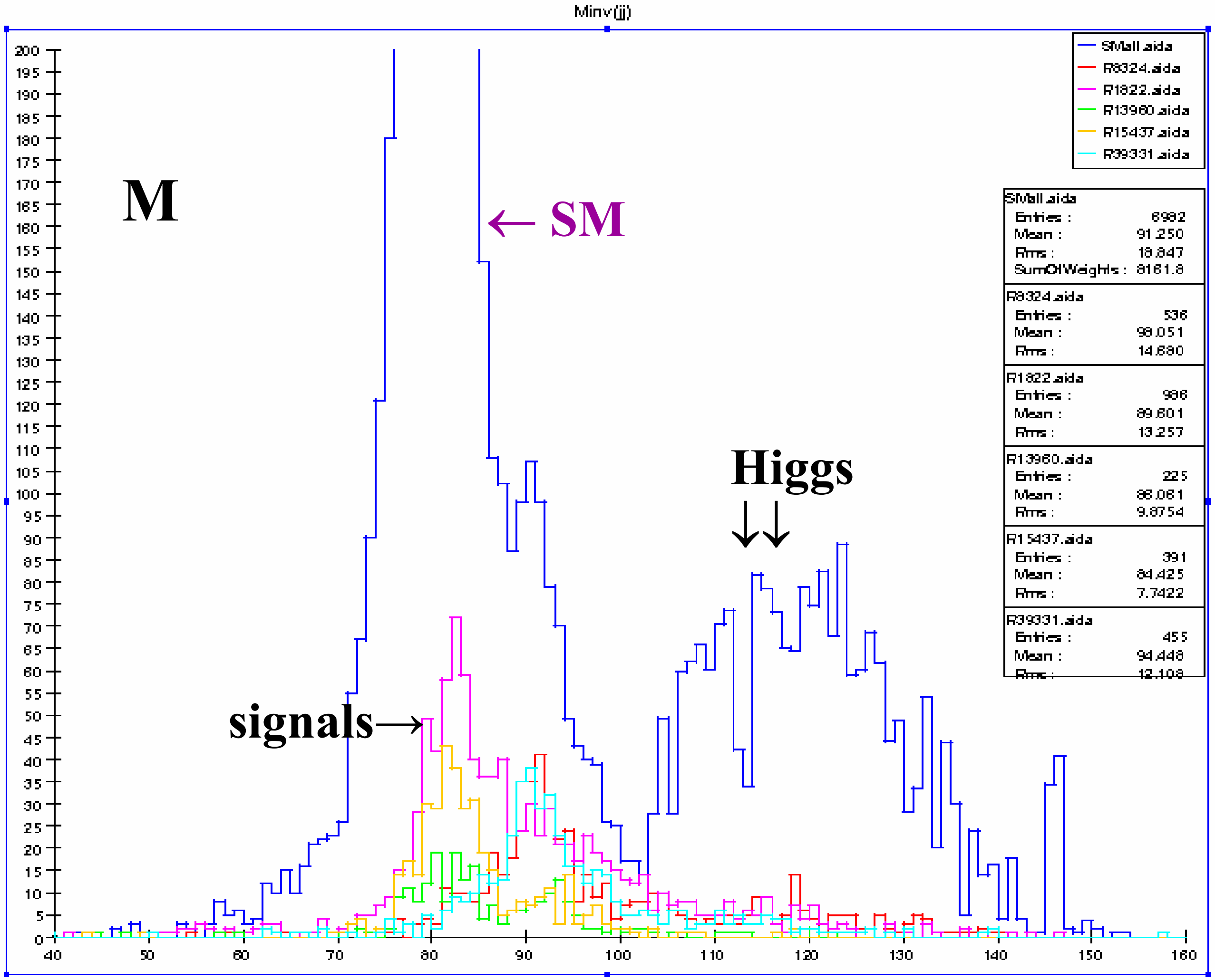
← H (non-b-tagged jets)

..but these set of cuts are too tight to produce ANY signal events and also we want to kill the both the W shoulder as well as the Z

….try again.

Changing cuts we now have the `best’ S/B ratio

SM Z almost



M

← SM

Higgs
↓↓

signals→

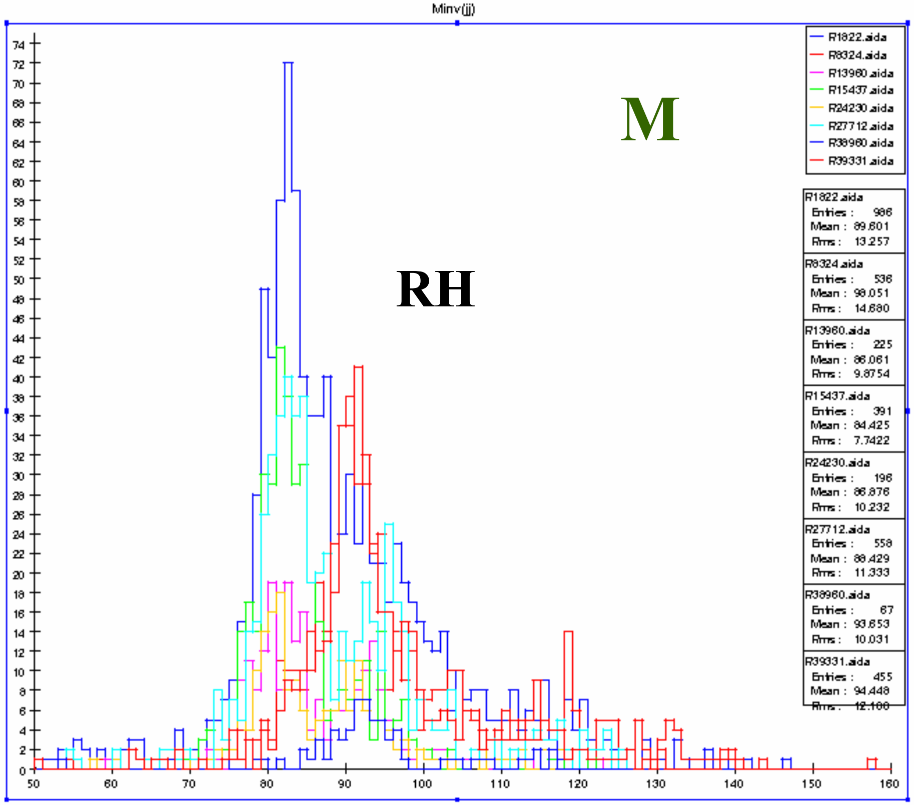
RH

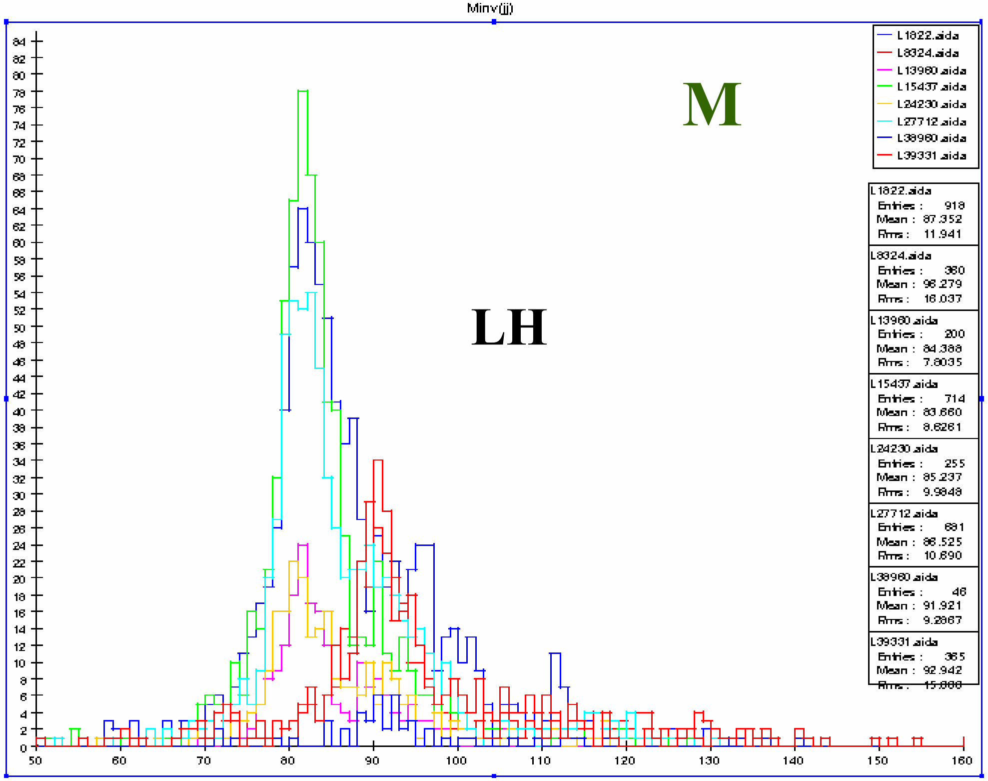
← Still all the signals are reasonably small yet some may be visible

Let’s look at the signal only

We see that the signals for either polarization are quite small but might still be

Contrary to claims, this is not an easy channel for our models.





Note feed-down from other particle decays..

A detailed study of cuts help somewhat with S/B in this case…

LESSON

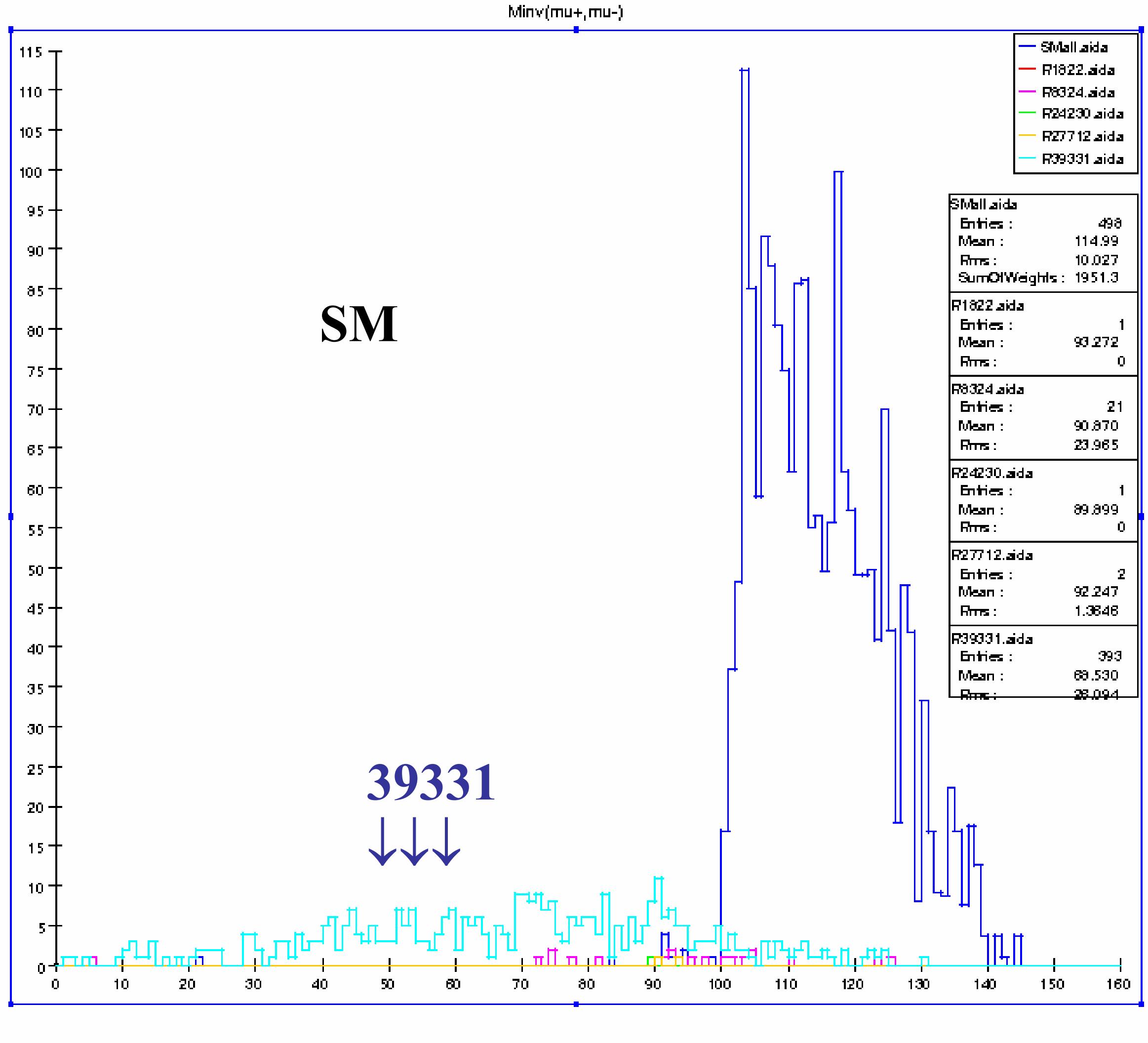
As we have

``SUSY IS A BACKGROUND FOR SUSY''

Just because you are looking for smuons or
or neutralinos doesn't mean what you *do* find is the
state you are actually looking for…though it is

E.g., more models may pass our `staus search' criteria than there are models with kinematically accessible staus… BUT models with *real* staus can be somewhat tricky to find. This is true for other analyses as well and we are just beginning to access this result....

$\chi_2^0 \chi_1^0 \rightarrow \mu\mu$ + Missing E Analysis



The signal rate is low…unfortunately

Here we see muons being produced by chargino pairs in model 39331.

Analysis

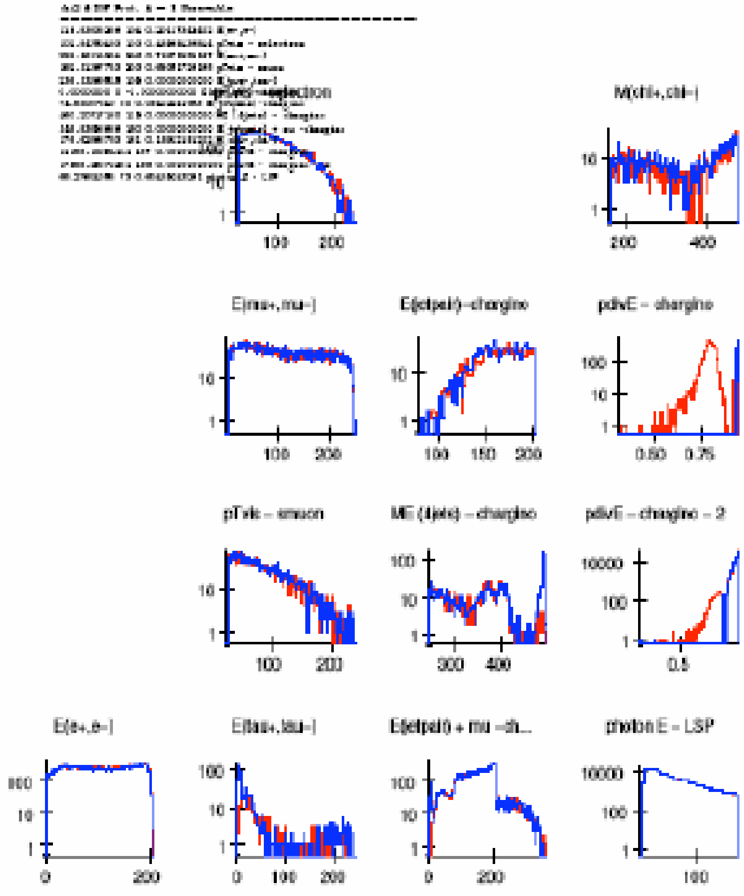


Figure 1: Left 207 (red) 3848 (blue)

- We combine the results for each analysis of Model A and Model B with those obtained from two different full background samples, B1 & B2
- For each e- polarization we perform a statistical comparison of the various distributions for (A+B1) vs (B+B2)
- We then ask if the 2 models are distinguishable at a given level of significance, e.g, 5σ
- We're just starting to do these comparisons

Here's an example of an old analysis where you the differences in both the sleptons and the

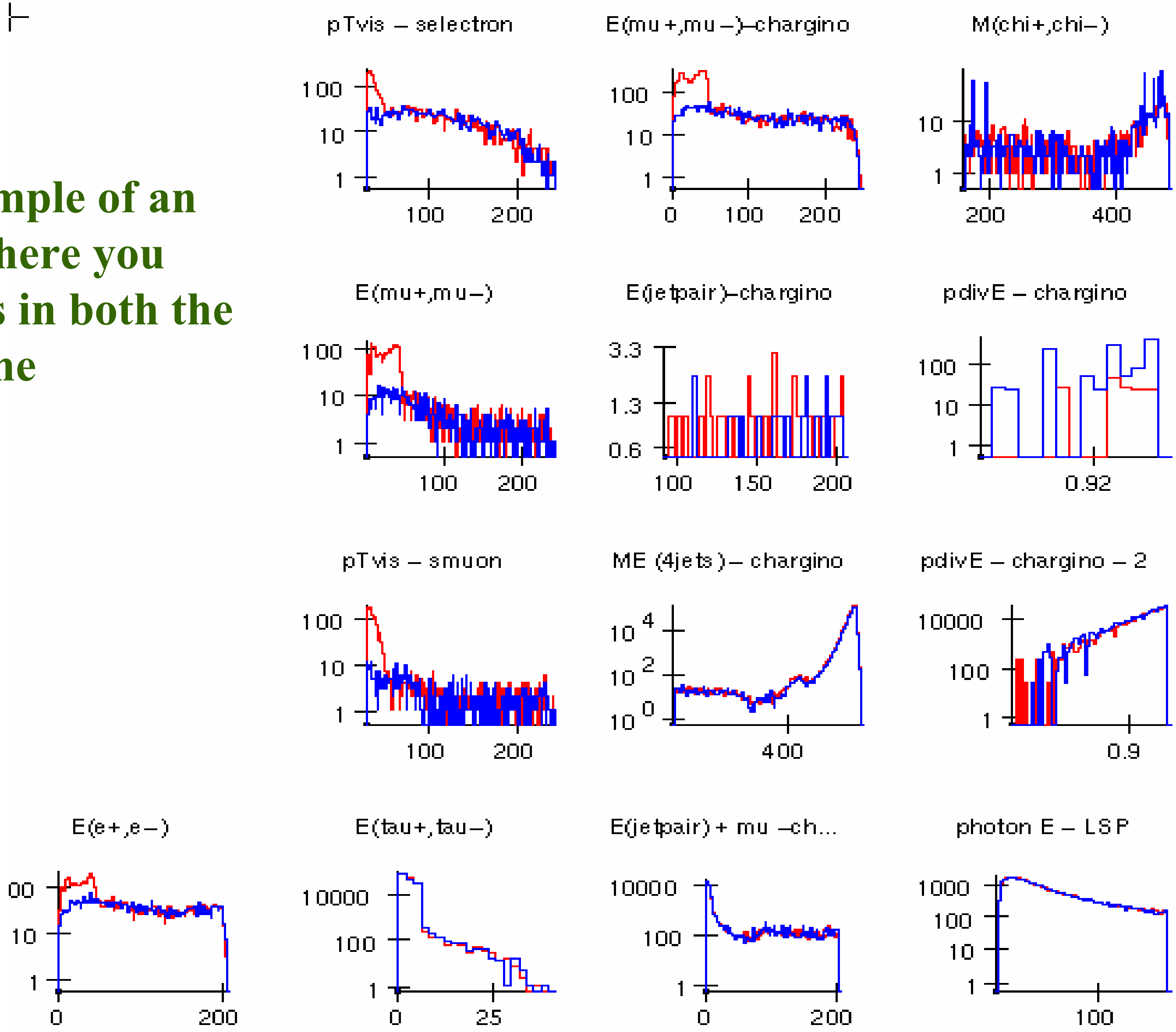


Figure 111: Right 10197 (red) 13274 (blue)

…and here is another also showing significant differences…

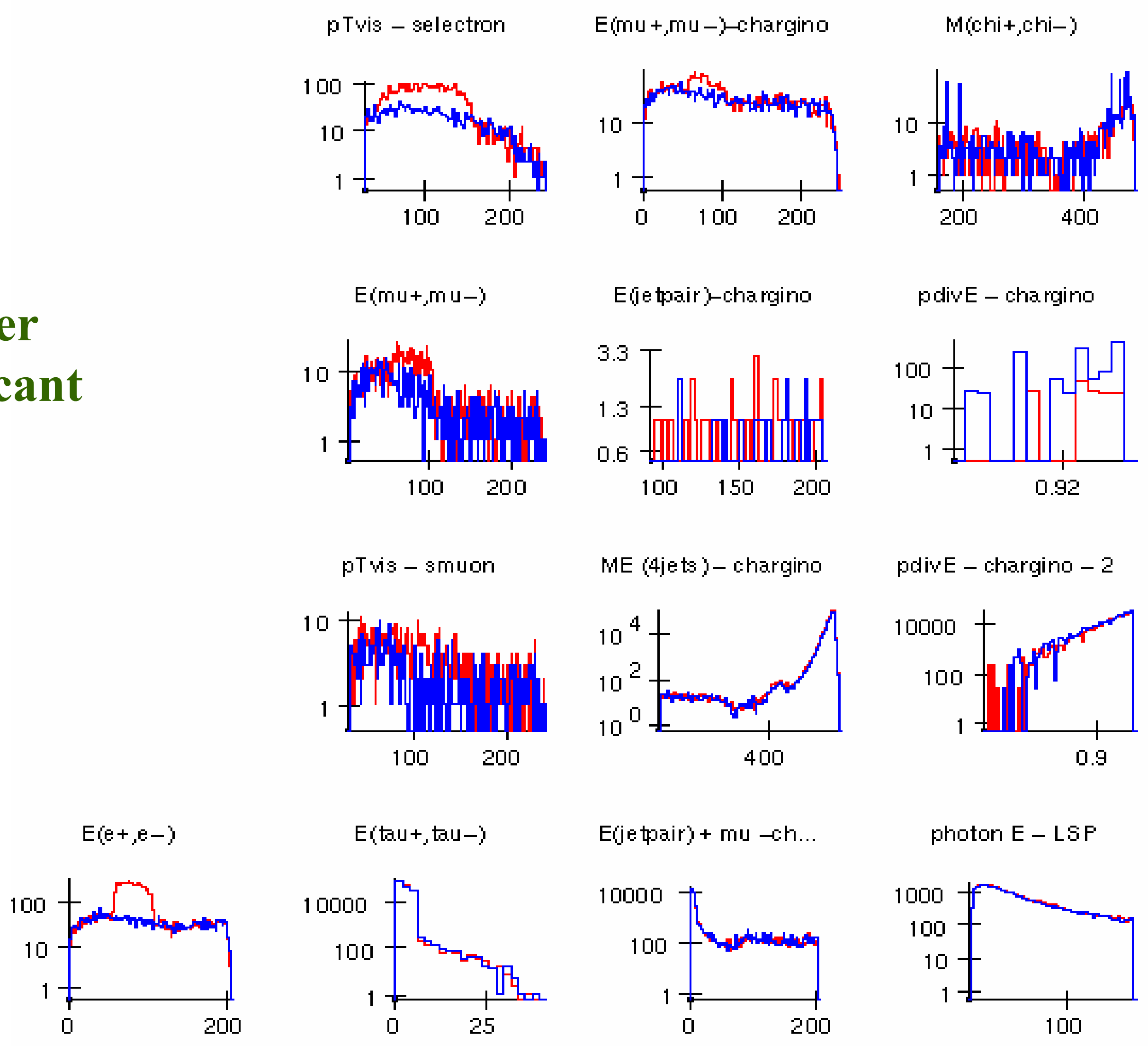


Figure 213: Right 27913[213] (red) 43006 (blue)

SUMMARY

This project has been a learning experience….and full of many surprises. The first round of our analysis is now reaching its completion (so that we can finally get a paper out!) but there are many extensions to the present work we wish to pursue…

(*i*) Study the 1 TeV case and the influence of positron polarization on both signals and backgrounds (more channels to look at). Do threshold of some kind….

(*ii*) Explore using CompHEP to generate SUSY signal events for all analysis channels which allows for interference.

(*iii*) Study variations in the detector properties, in particular, the effect of introducing low-angle tracking below ~140 mr.

(*iv*) Begin a completely new analysis with a more realistic set of models which includes other constraints from, e.g., the Tevatron, LEP, 2, $b \to s\gamma$, dark matter searches, etc.