Inclusive Search for SUSY @ ATLAS

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Short presentation of the problem

The LSL algorithm

Results: Search for SUSY @ ATLAS

The Problem

We know that supersymmetry must be broken but we don't know how.

Is MSSM the right scheme? → *The neutralino is the LSP*

Is GMSB the right scheme? → *The gravitino is the LSP*

Maybe AMSB the right scheme? Or *XY*SB?

Do we really care which is the identity of the LSP?

Is R parity conserved at all???

Will SUSY give rise to large missing energy final states?

You ain't seen nothing

Even if we were told that, say, MSSM is the "right" model we still won't be able to predict the experimental signatures. There are too many free parameter in the model (and different generators give different results is some regions of the parameter space).

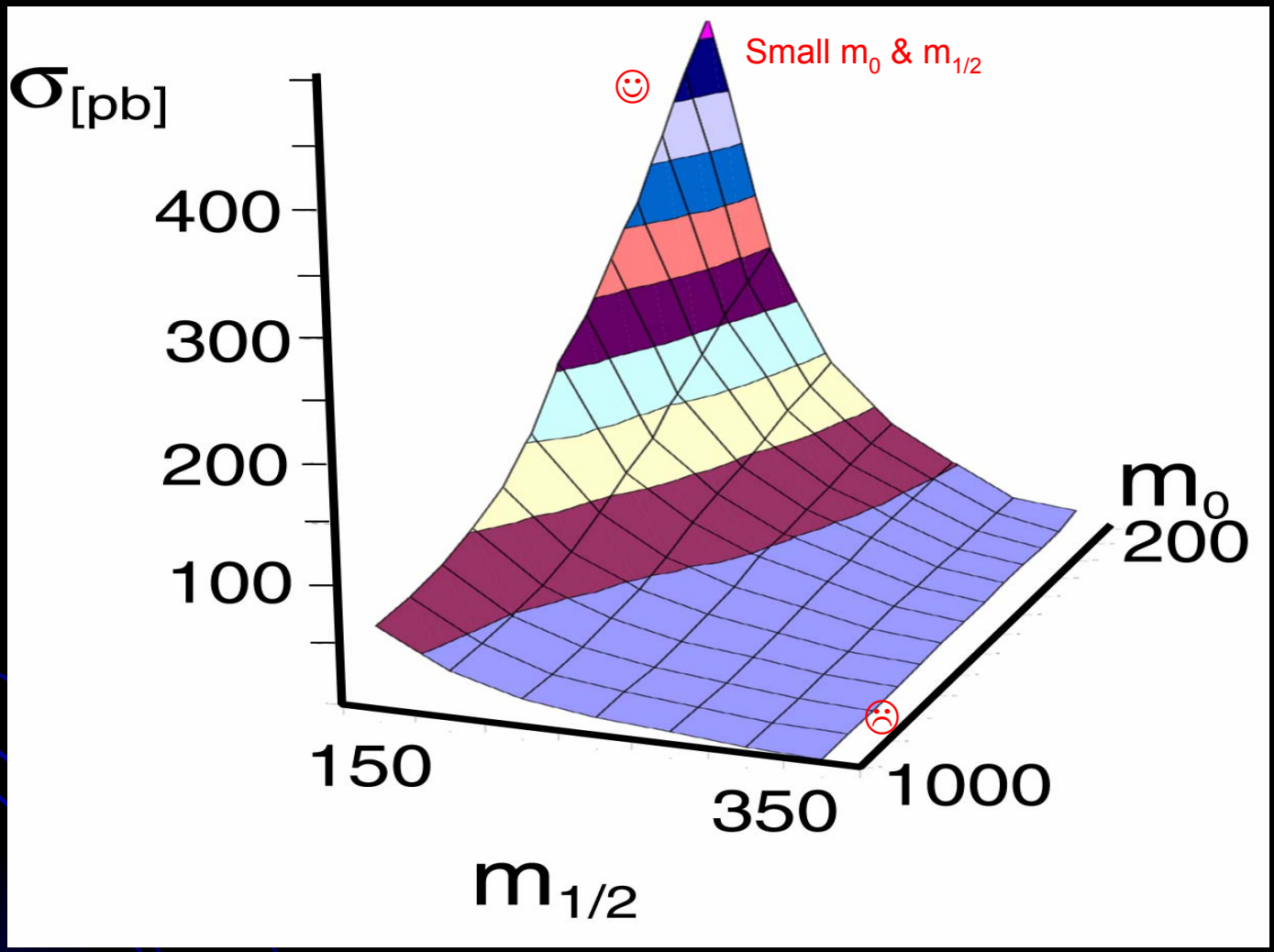
So we don't know what we are looking for !!!!

Temporary working assumptions

* R parity is conserved (RPC)
* MSSM

Still unknown parameters $m_{1/2}, m_0, \tan\beta, A, \mu$

MSSM Cross-Section

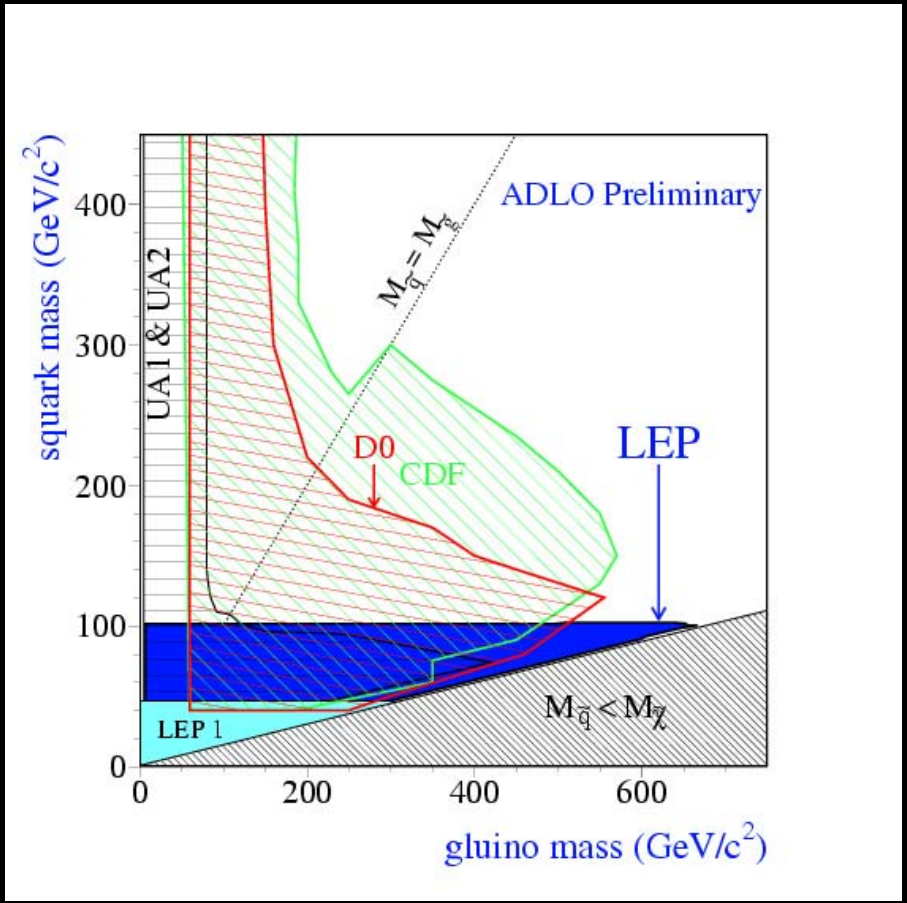


Can be HUGE ("instantaneous" discovery), or very small. Depending on SUSY Nature

Not in the entirely in the dark

1. Know the R-Parity Conserving SUSY (RPC) leads to the production of two 'neutrino-like' *LSP* (Lightest SUSY Particle) ➔ **Large missing transverse momentum.**

2. SUSY particles are **heavy**➔



Inclusive Search Algorithm

Aim: Look for an unknown signal

i.e. abnormal excess of events '**somewhere**'

In order to define the '**somewhere**' one must impose some physics input. When looking for SUSY signal 'somewhere' means high mass, high $\not{P}_t$. In other words one must define some quantities by which each event will be characterized. e.g.

- $\not{P}_t$;
- Σp_t(jets);
- P_t(highest jet);
- P_t(highest lepton).

One can then represent each event as a point in an n-Dimensional space, where each of the above quantities is an axis.

This procedure is performed first to a simulated sample in which all SM are included (*background*) and then it is repeated to the data

A region, in this n-dim space, in which the density of events in the data is significantly higher than that in the background sample might contain a signal

Large signals will be seen anyhow. Such a procedure will be important where the signal is small, i.e. when SUSY is heavy

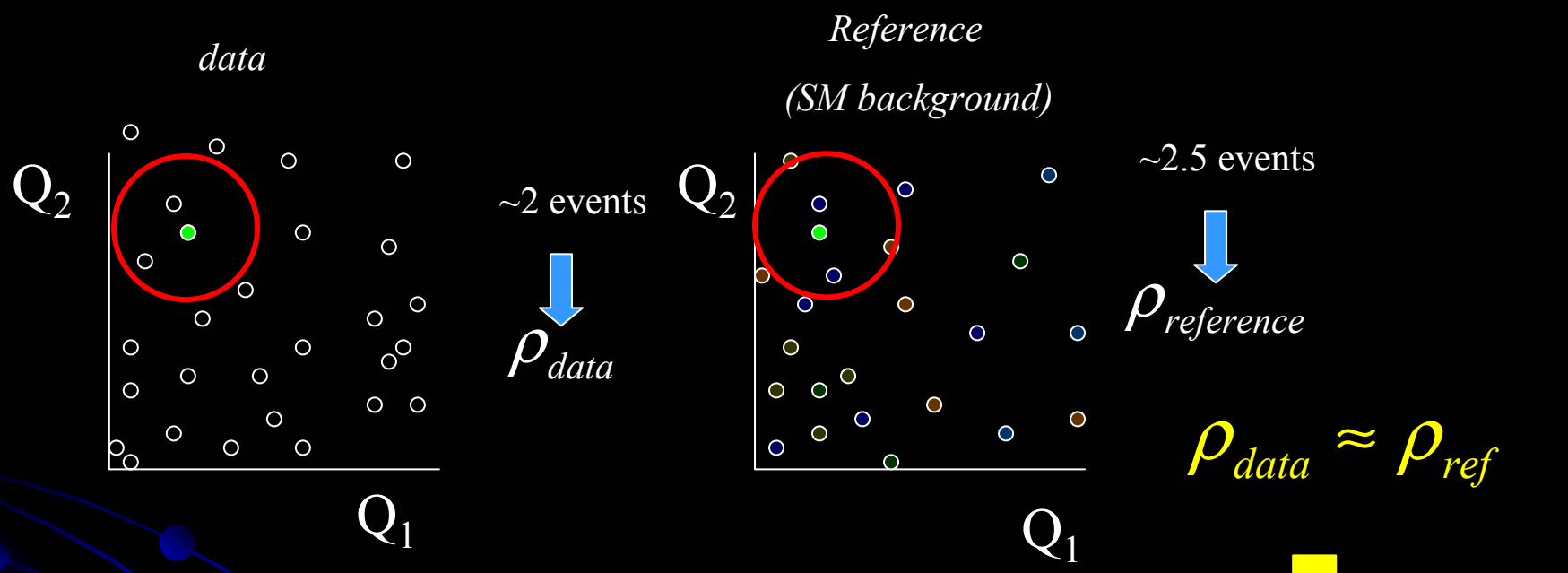
The LSL Algorithm

The Local Spherical Likelihood (LSL) algorithm is based on the k-neighborhood one.

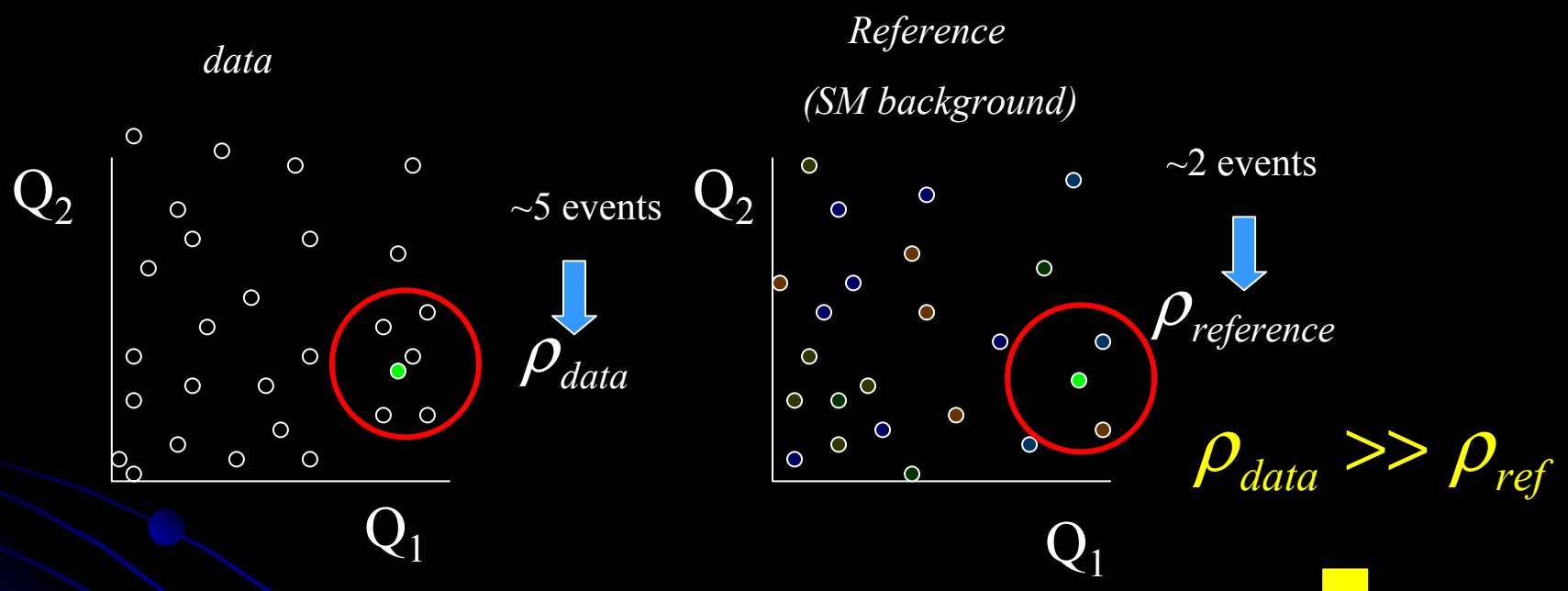
Preparation:

- Select the relevant quantities, say N (separators);
- Normalize the separators to [0,1];
- Simulate all known SM (Background) processes;
- Construct a '*reference*' n-dim space in which each b.g. event is represented by a point
- Repeat this procedure for data events and build the '*data*' space in which each data event is represented by a point

How it Works (simplified)

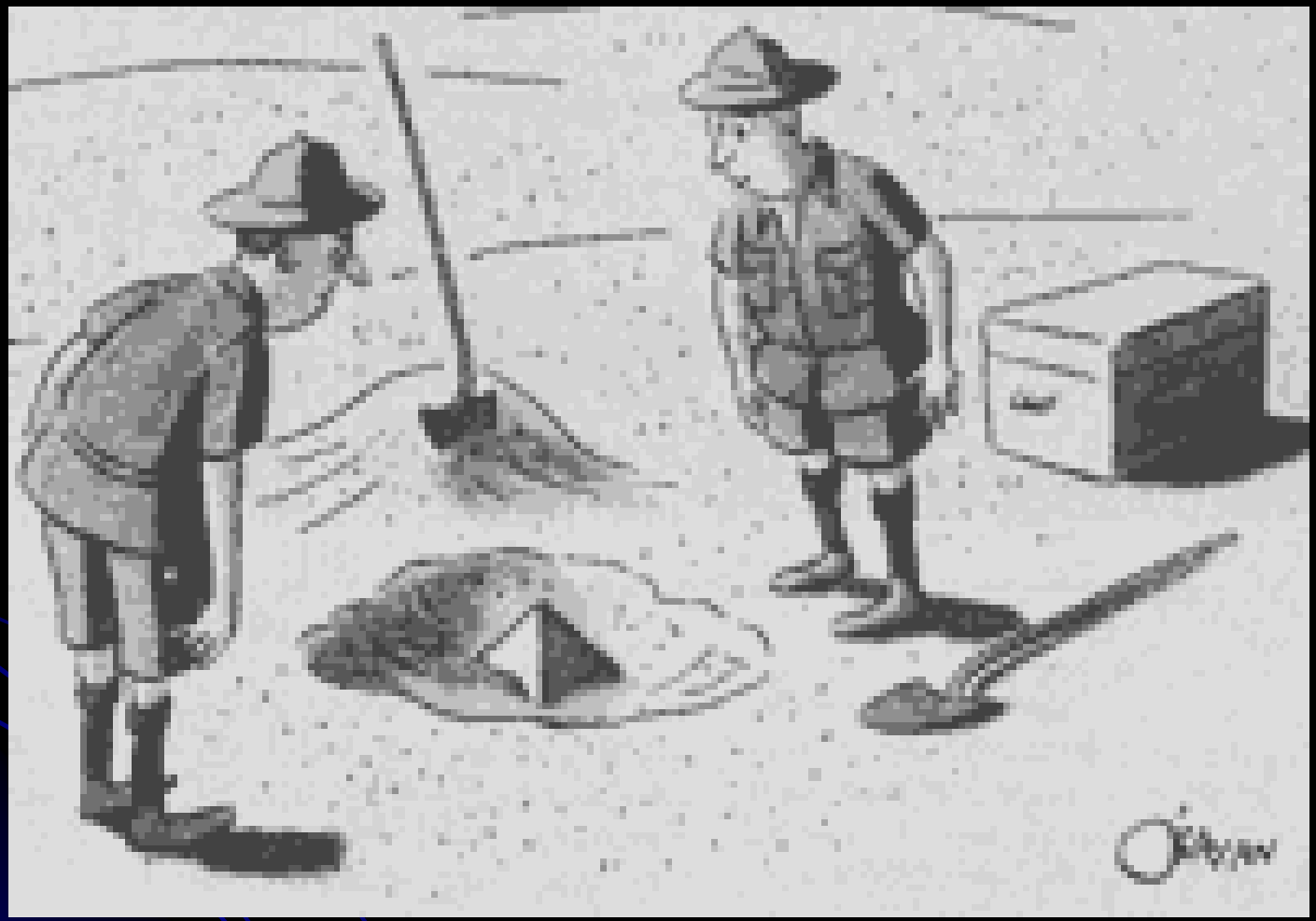


How it Works (simplified)



A hint for a signal

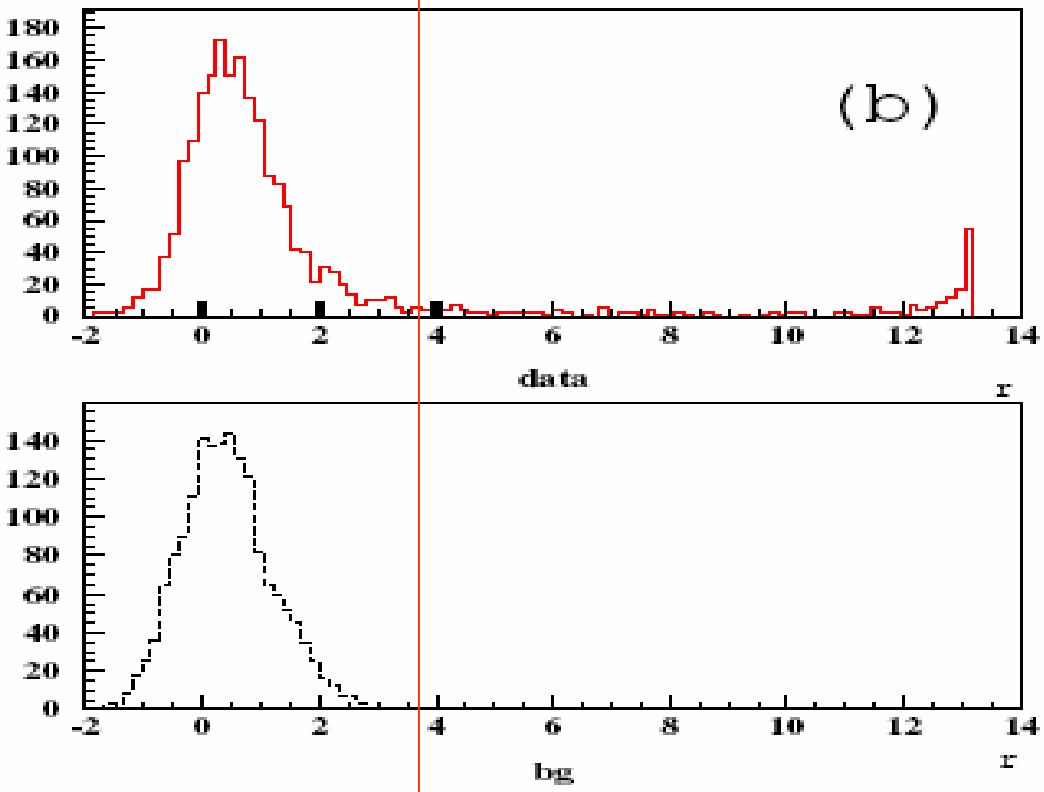
".This could be the discovery of the century.



Depending of course, on how far down it goes"

Density distribution

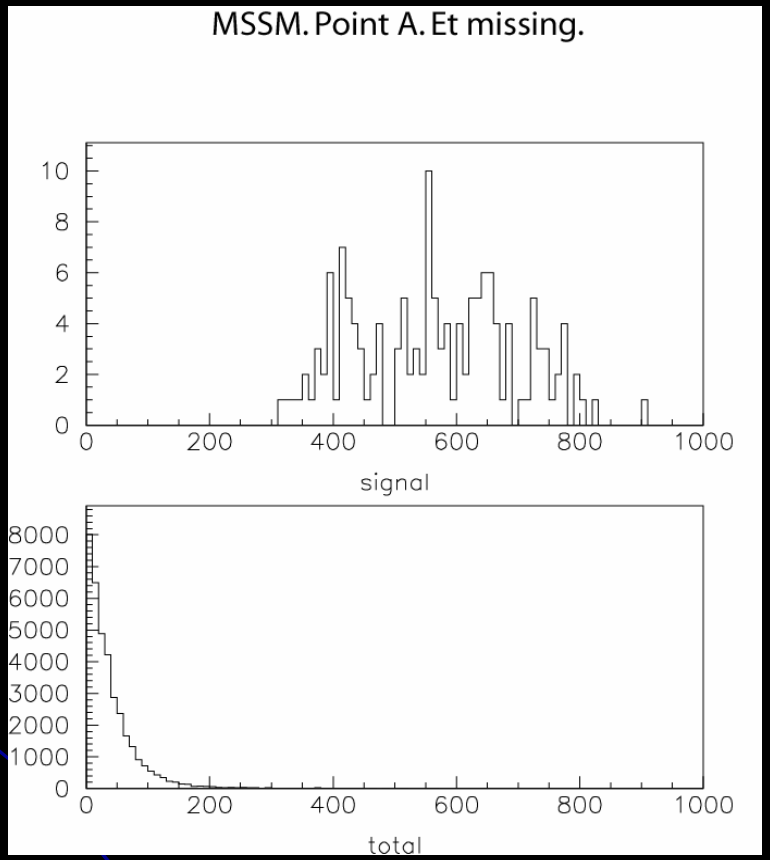
Signal candidates



'Data' with signal

'Data' without signal

Good Old 'Smoking Gun'

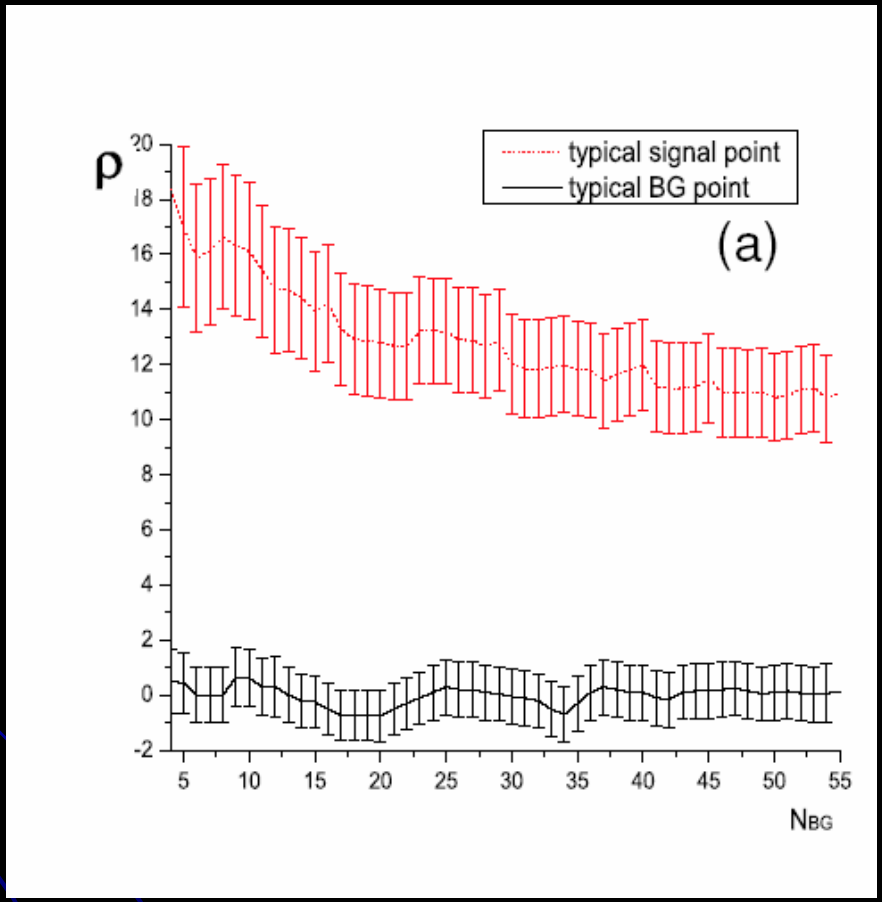


High ρ events

Low ρ events

Plot the missing energy of LSL-selected candidates (above)

Optimizing the Sphere Size



The relative density as a function of the sphere size (in number of events)

Optimization

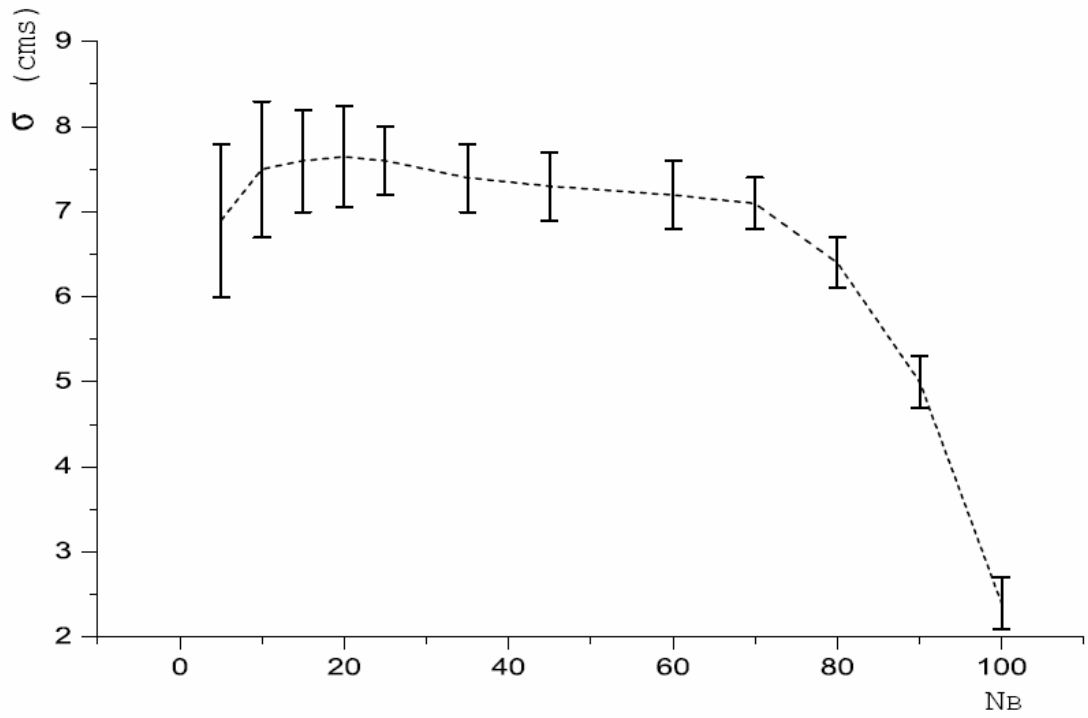
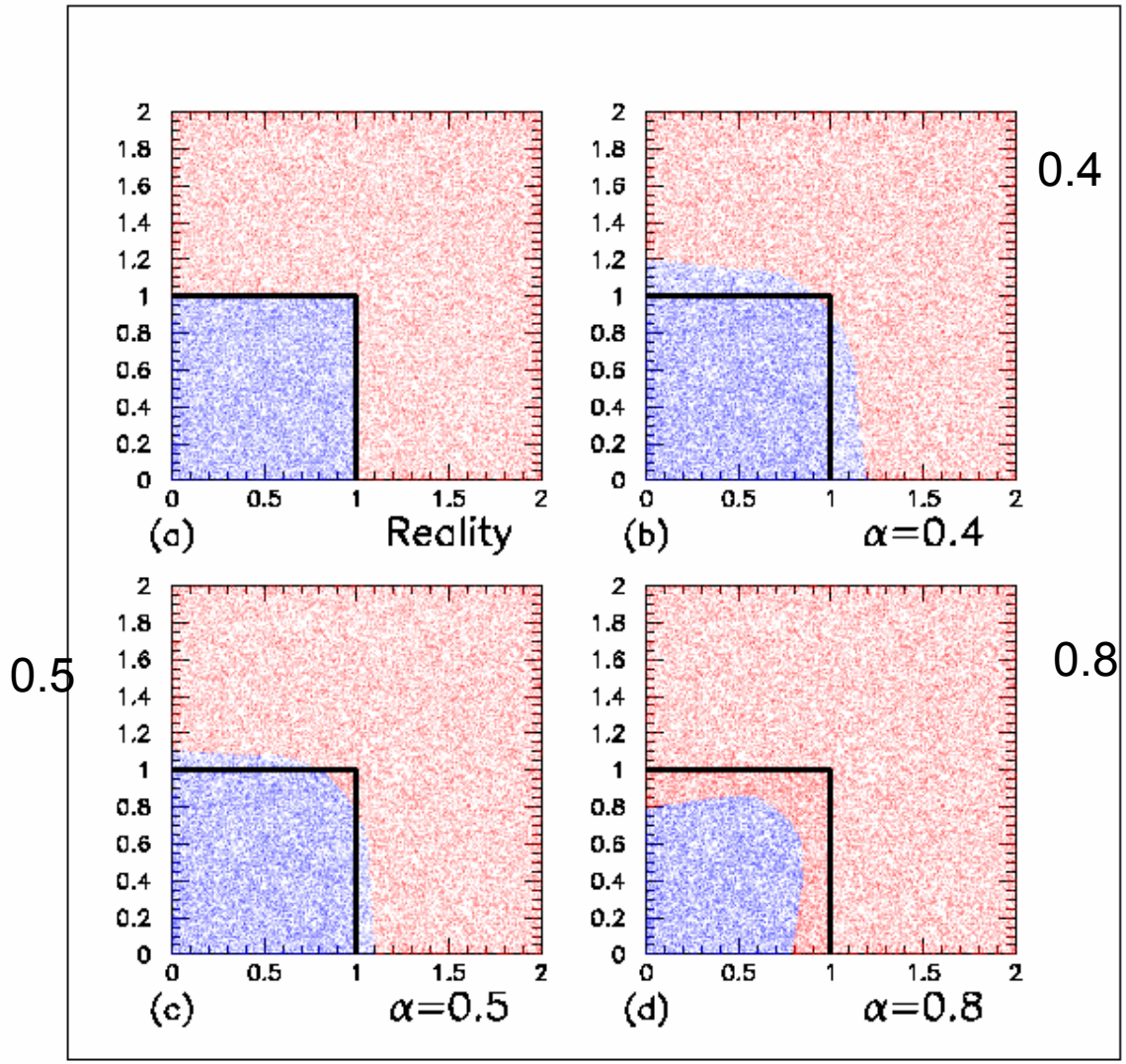


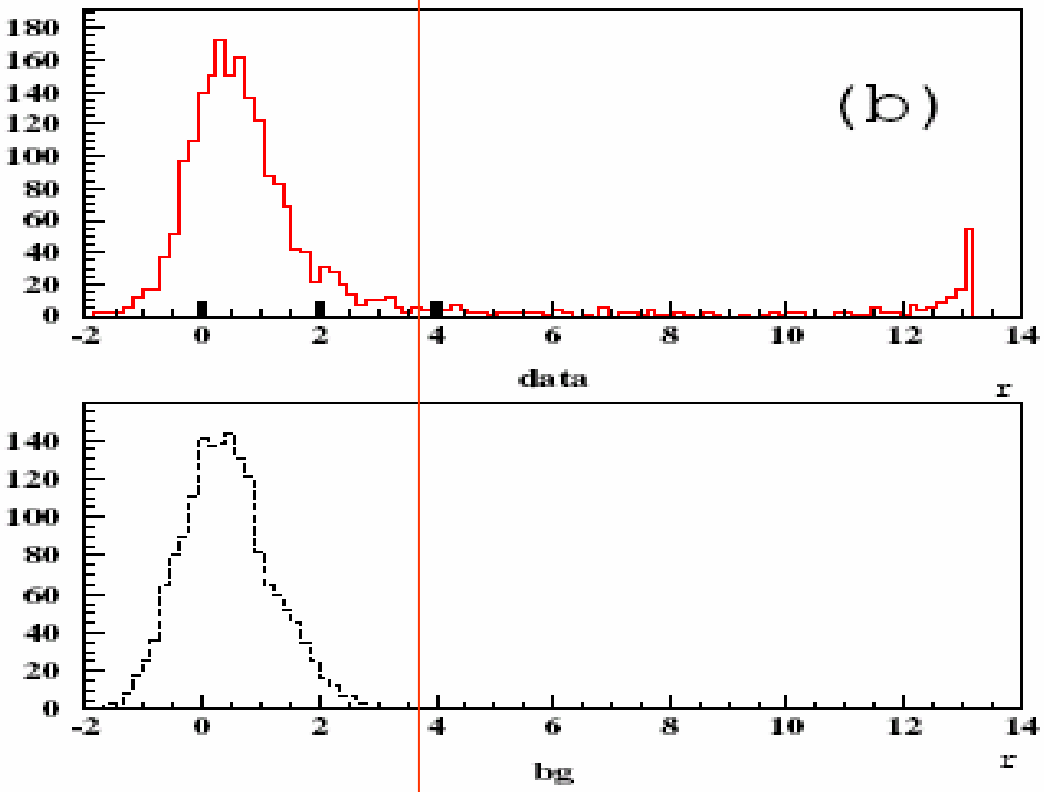
Figure 2: The statistical significance of the MSSM search analysis as a function of N_B.

What is a Signal?



Density distribution

Signal candidates



'Data' with signal

'Data' without signal

Stability Tests

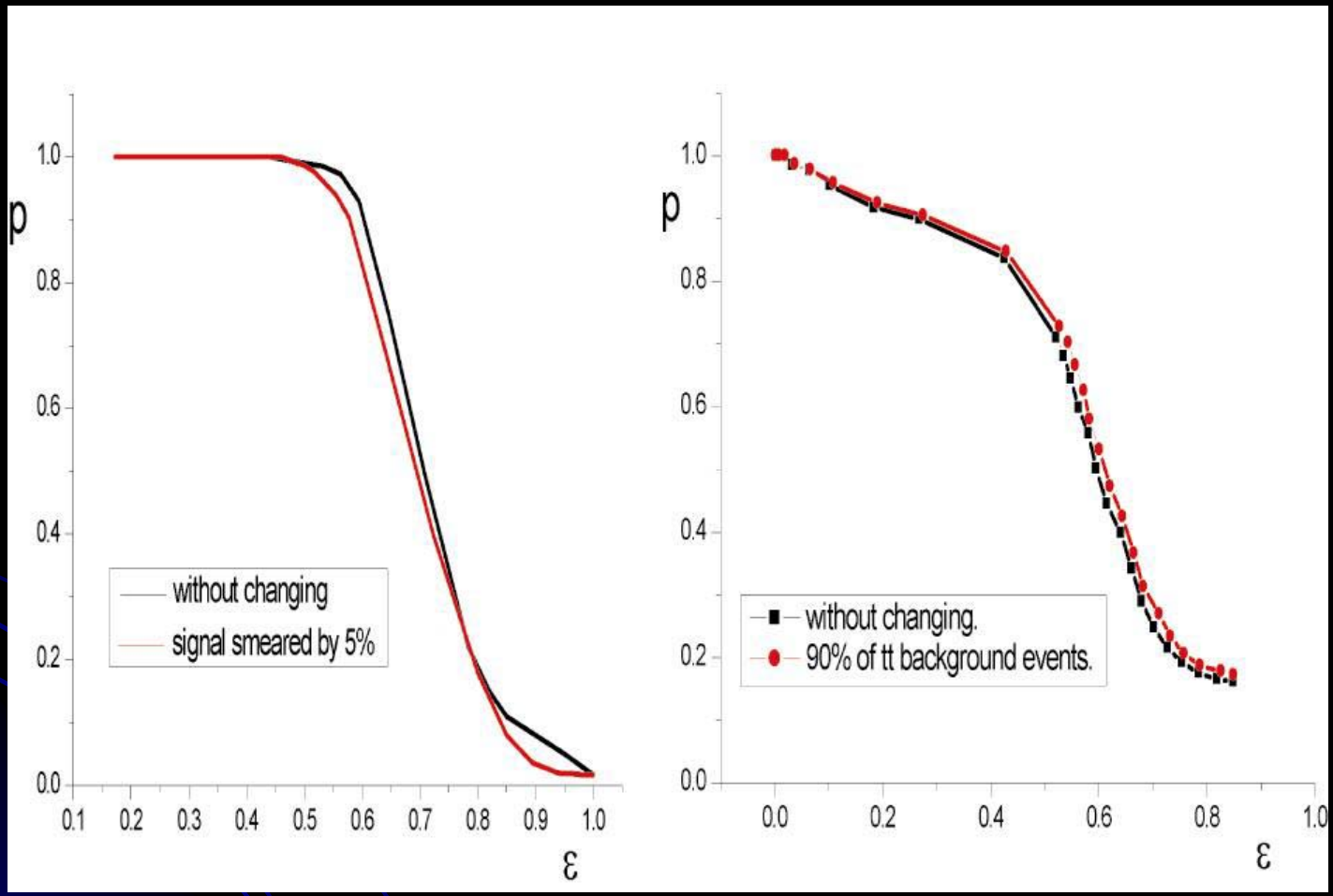
Few stability tests have been applied (more to come) like:

- Scaling up/down the various ratios of b.g. processes;
- Different normalization of input parameters;
- Up/down shifts in values of input parameters.

Generally speaking the outcome is stable

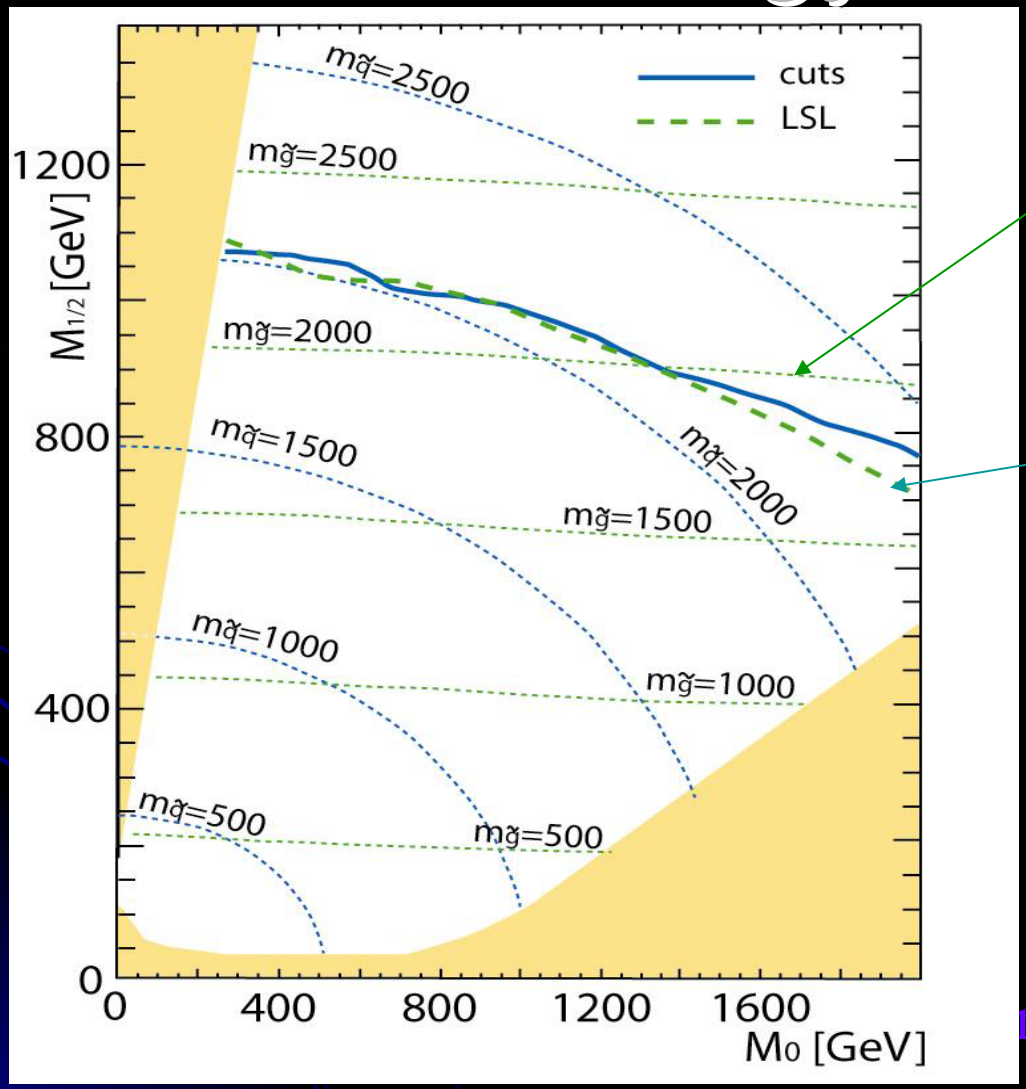
Inefficient when too many (O(10)) input parameter are used

Stability Results



hep-ph/0403270

MSSM Results – Missing Energy



$M_{1/2}$

Dan Tovey simplex results

LSL

Sensitivity for 10fb^{-1}

m_0

Working Assumptions

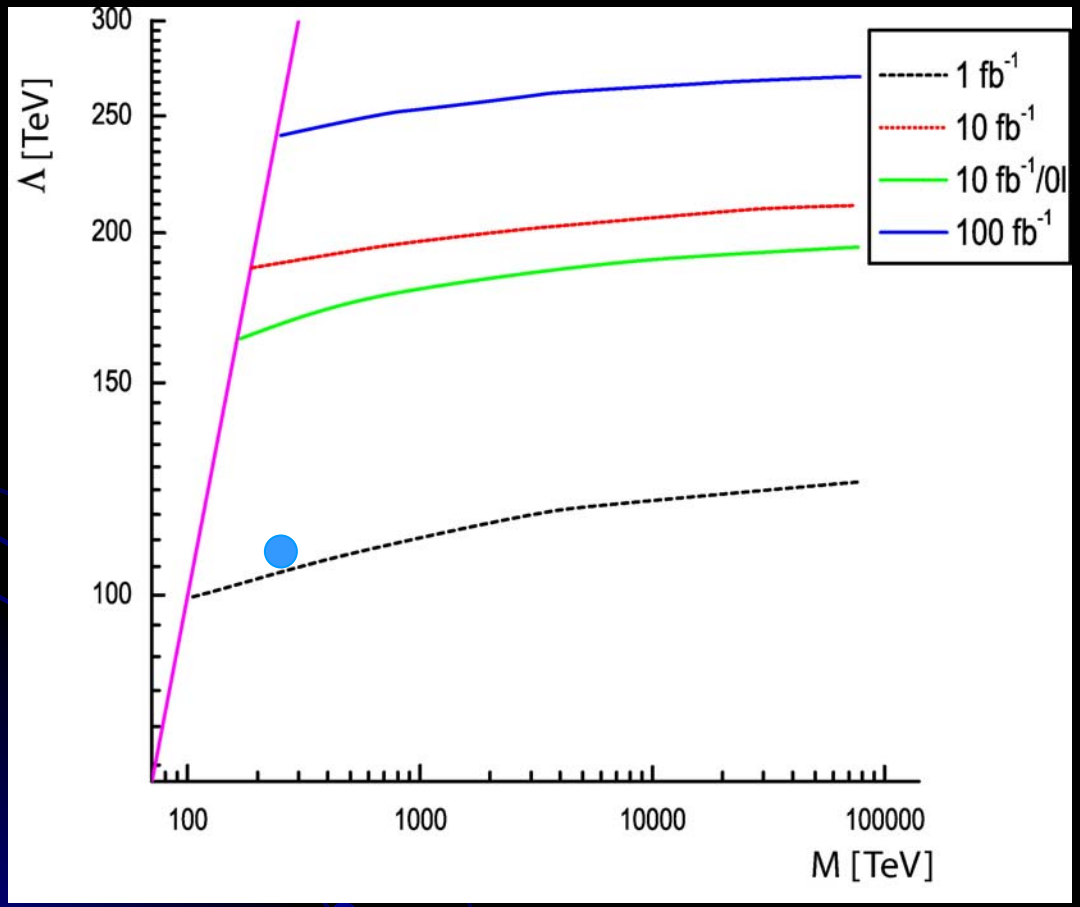
* R parity is conserved (RPC)
* ~~MSSM~~

GMSB

AMSB

Without changing neither the reference nor the procedure. Only new signal is ‘injected’

Results - GMSB

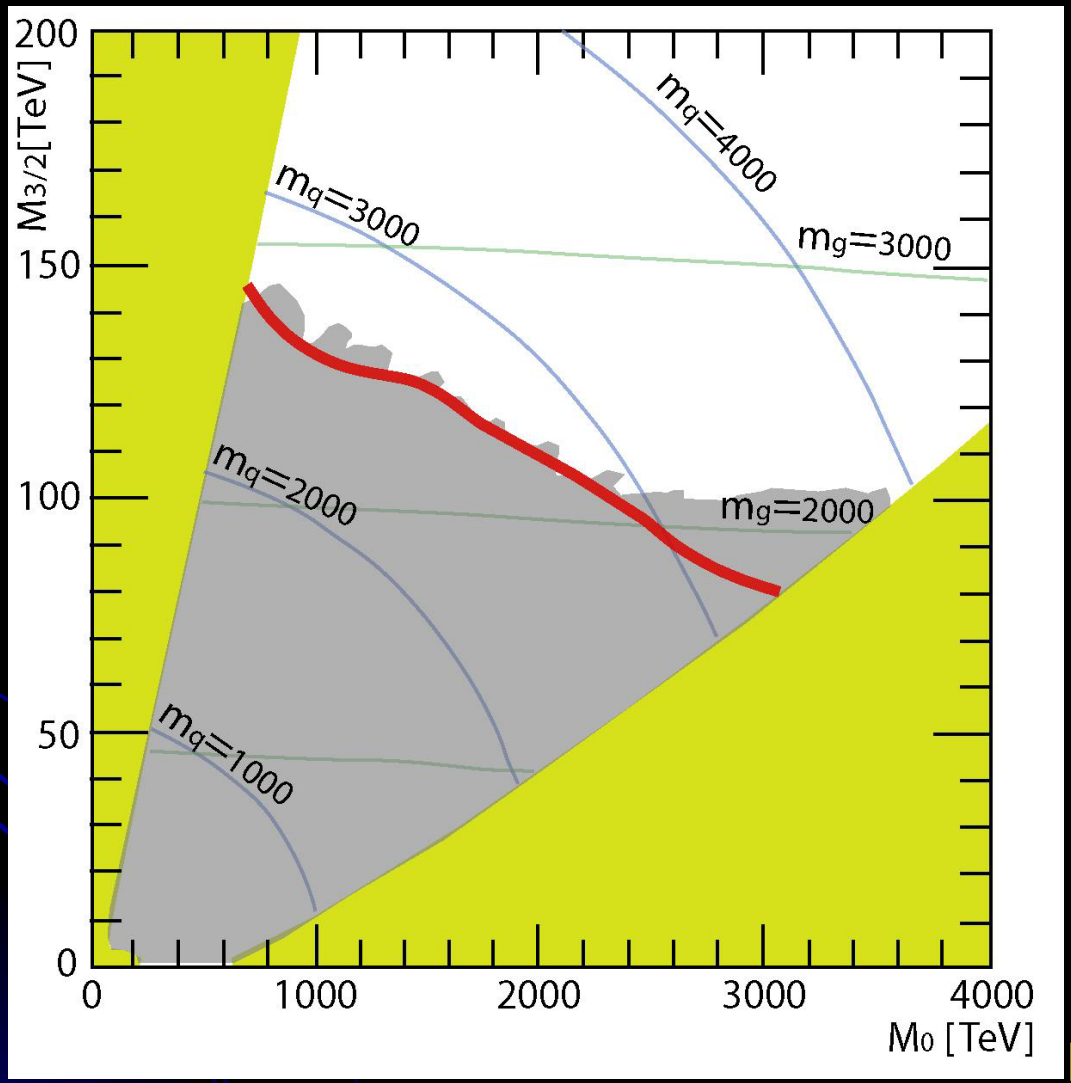


Sensitive up to Λ=120TeV

With lumi of just 1fb^{-1}

Results - AMSB

$M_{3/2}$ [TeV]



Comparison with
A. J. Barr et al.

HEP-PH-0208214

M_0 [TeV]

Conclusion

An new algorithm for inclusive searchs is presented.

Its sensitivity is comparable to the one obtained by dedicated ‘signal-driven’ studies.

Its scope it much wider.

It is hard to believe that such an algorithm can replace the dedicated searches and probably a combination of both will have to be used.

Still to be done

Include ‘intermittent’ parameters.