SUSY: experimental review

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In the 2012 Review of Particle Properties, the experimental SUSY review has been updated significantly.

Retirement of (irreplaceable icon) J-F Grivaz
Taken over by Oliver Buchmüller and Paul de Jong

But also reflecting the upcoming influence of the LHC in experimental SUSY

The review is traditionally focused towards direct searches for SUSY, i.e. the *direct observation of sparticles* (usually via decay products…)
No attempt to fully cover SUSY constraints from precision experiments (Very hard to find a coherent framework to do so.)

Structure of the review:

II.1. Introduction
II.2. Experimental search program
II.3. Interpretation of results
II.4. Exclusion limits on gluino and squark masses
    II.4.1. Exclusion limits on the gluino mass
    II.4.2. Exclusion limits on first and second generation squark masses
    II.4.3. Exclusion limits on third generation squark masses
II.5. Exclusion limits on slepton masses
    II.5.1. Exclusion limits on the masses of charged sleptons
    II.5.2. Exclusion limits on sneutrino masses
II.6. Exclusion limits on masses of charginos and neutralinos
    II.6.1. Exclusion limits on chargino masses
    II.6.2. Exclusion limits on neutralino masses
II.7. Global interpretations
II.8. Summary and Outlook

LHC influence:

High $\sqrt{s}$ pp collisions: highest sensitivity in direct searches
in particular for colored particles: squarks/gluinos

At the time of the 2012 review: final results 5 fb^{-1} at $\sqrt{s}$ = 7 TeV
preliminary results ~5 fb^{-1} at 8 TeV

Dominated by general, inclusive searches like jets + E_T^{miss} (+X)

Interpretations: diminishing influence of constraint models like MSUGRA/CMSSM
'simplified models' started to become more important
- focus on specific production/decay modes
- yet, study full variation of free parameters (masses)
- useful to see where an analysis 'breaks down'
- no 'fake' sensitivities from hidden assumptions

gauge mediation: GMSB → GGM

But also in 2012: still significant influence LEP, Tevatron, HERA

Since 2012 RPP:

A total of 20 fb^{-1} at $\sqrt{s}$ = 8 TeV collected at the LHC.
Still no significant sign of SUSY in the data

Available so far:

- A very large number of, mostly preliminary, results of direct searches
- A few (new) trends and observations follow in the next slides

And of course: the confirmation of the 126 GeV boson
determination of its properties to be VERY Higgs-like.

Trends and observations:

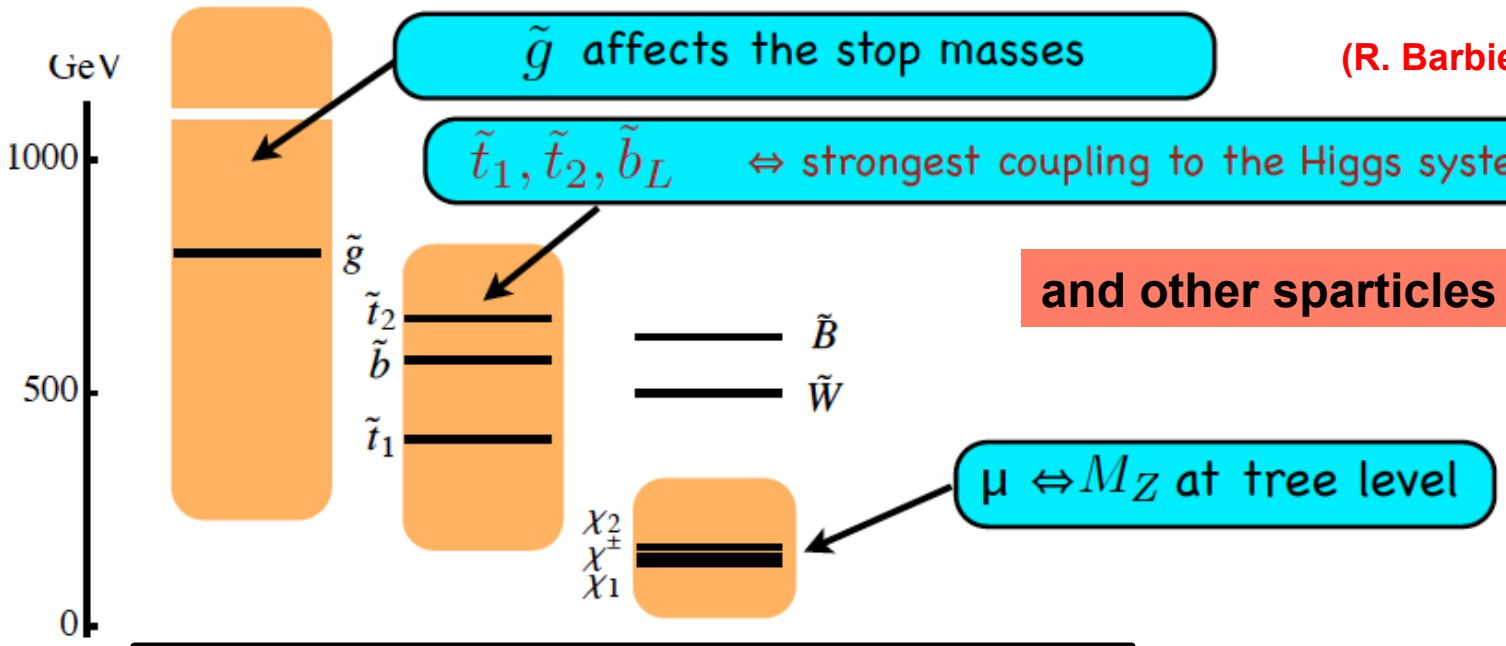
Inclusive searches still going strong.

More varied analyses, more final states, stronger and more specialized limits

Each analysis typically interpreted in a number of simplified models
(sometimes a quite large number)

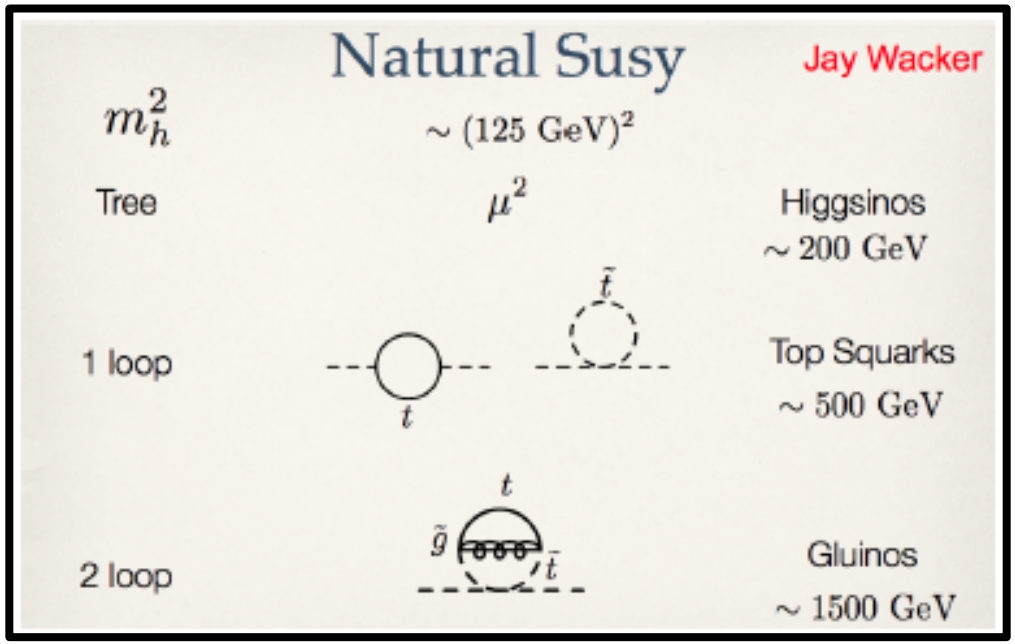
But also: many more targeted, dedicated and specialized analyses
Especially for 3rd generation squarks, motivated by 'naturalness' (i.e. Natural SUSY)

Naturalness:



(R. Barbieri, ICHEP 2012)

and other sparticles decoupled?



Since 2012 RPP many new results on:

- Searches for stop and sbottom
  - Releasing MSUGRA/CMSSM constraints, assuming 3rd generation lighter than first two generations of squarks
  - Simplified model grids, typically assuming specific decay modes
  - Limits surpassing CDF/D0 on all fronts
- Gauginos: charginos, neutralinos (other than the LSP)
  - Simplified models, or in MSSM as function of M_1, M_2, μ and tan β
  - LEP limits still play an important role

We plan to update c.q. enhance sections on third generation and gauginos

Will mention naturalness as motivation, but do not want to overdo it:
exp searches simply want to fully cover the kinematics accessible by the LHC, and nature may have chosen not to be 'natural', or not in the way we currently understand it.

It should be noted that the sheer number of interpretation grids has exploded (see next talk)!

A 126 GeV Higgs boson: assuming this to be SUSY h:

Certainly, in general its properties and in particular its mass, disfavor/rule out regions of SUSY parameter space, and favor others.

Mass of 126 GeV: OK for SUSY in general

- In MSUGRA/CMSSM this implies: constraints on all squarks – not easy to accommodate
- MSSM → constrains squarks (in particular stop) but still OK
- Extensions such as NMSSM; easier to accommodate 126 GeV h

Production and decay properties:

Compatible with SM within current (large) uncertainties

But also with SUSY for a fairly large range of SUSY parameters

(rather large m_A in MSSM)

→ *by itself the observation of h at 126 GeV would not affect direct SUSY searches too much*

Again, experiments simply want to cover the full LHC kinematics as full as possible

However, the new 126 GeV boson certainly is not ignored:

Interpretations now take into account the assumption that m_h = 126 GeV
(i.e. model parameters are 'Higgs-aware')

126 GeV h appearing in grids used in analyses
(e.g. $\chi_2^0 \rightarrow \chi_1^0$ + h, etc.)
active searches for h in SUSY chains in progress (but few public results yet)

Limits on invisible h decays (e.g. to neutralinos)

Searches for heavier Higgses covered in Higgs review