

Implications of LHC Searches on Constrained Supersymmetric Models

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IPPP
University of Durham

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The MasterCode Collaboration

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Implications

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Theorists

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Fit Details

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Statistical Measure

$$\chi_{tot}^2 = \sum_{obs} \chi_i^2 = \sum_{obs} \frac{(C_i^2 - P_i^2)}{\sigma_i^2}$$

- For derived quantities σ_i incorporates both experimental and theoretical errors.

Fit Method

- Use Markov Chain Monte Carlo for sampling, with χ^2 minimisation using `Minuit` as an 'afterburner'.
- Sample $\mathcal{O}(10^8)$ points for CMSSM/NUHM.
- Frequentist interpretation of results.

Best-fit Points (before LHC data)

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Model	Min χ^2	Prob	$m_{1/2}$	m_0	A_0	$\tan \beta$
CMSSM	21.5	37%	360	90	400	15
NUHM1	20.8	29%	340	110	-520	13

Comments

- CMSSM/NUHM: Preference for light SUSY, with $m_{\tilde{q}} \sim m_{\tilde{g}} \approx 600 - 700$ GeV
- Small $\tan \beta$, with $\tilde{\tau}$ co-annihilation.

New Constraints

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SUSY searches (jets plus MET).

$$BR(B_S \rightarrow \mu^+ \mu^-)$$

$$H/A \rightarrow \tau\tau$$

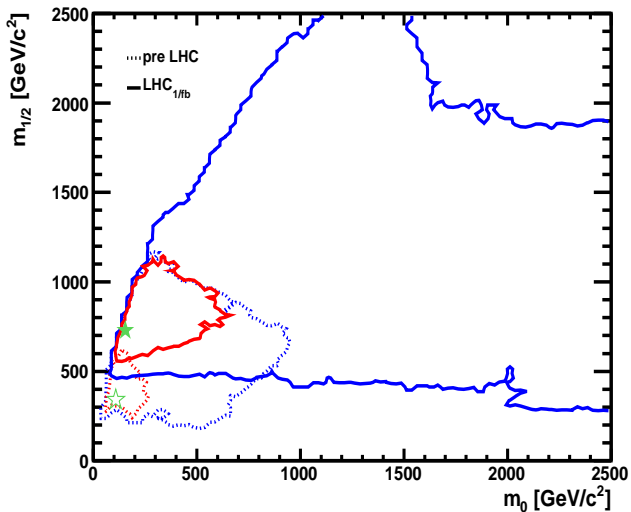
Direction detection constraints from XENON100.

Hints of m_h at ~ 125 GeV?

NUHM m_0 - $m_{1/2}$

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Best-fit points: NUHM1

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Model	$\chi^2/\text{d.o.f.}$	Prob	$m_{1/2}$	m_0	A_0	$\tan \beta$
NUHM1	20.8/18	29%	340	110	-520	13
LHC _{1/fb}	27.3/21	16%	730	150	910	41

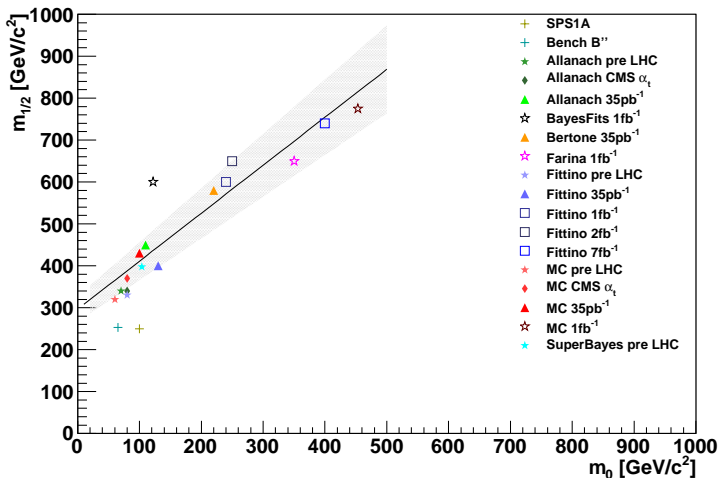
Comments

- Drop by factor ~ 2 in p-value.
- $\tan \beta$ increases by ≈ 30 .

Trend of Best-fit points

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Implications: What if $m_h = 125$ GeV?

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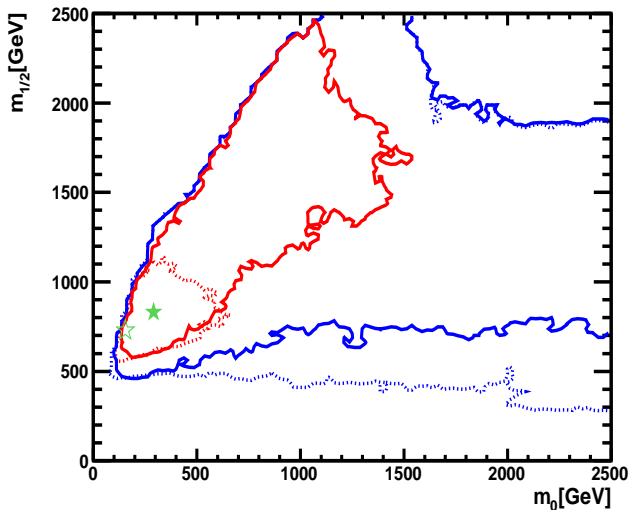
Model	$\chi^2/\text{d.o.f.}$	Prob	$m_{1/2}$	m_0	A_0	$\tan \beta$
pre-Higgs	26.9/21	17%	730	150	-910	41
Inc. Higgs	29.7/22	13%	830	290	660	33

Comments

- Likelihood is quite shallow for both models
- Goodness of fit decreases further to 13% for both models.

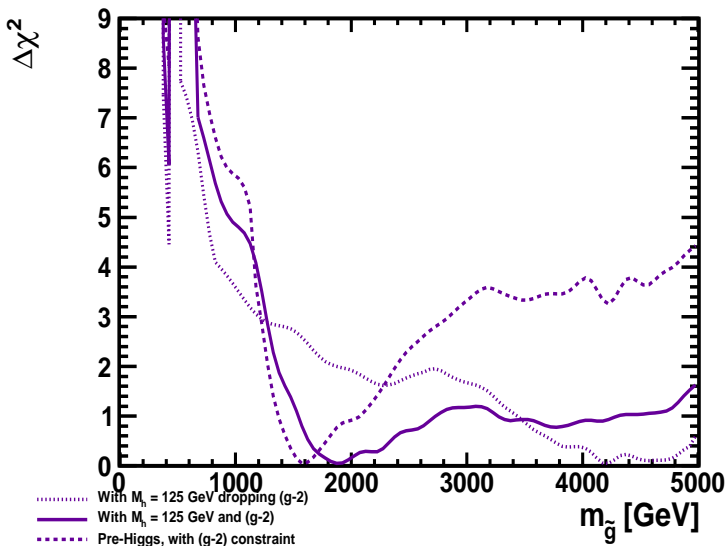
NUHM1 with putative m_h measurement

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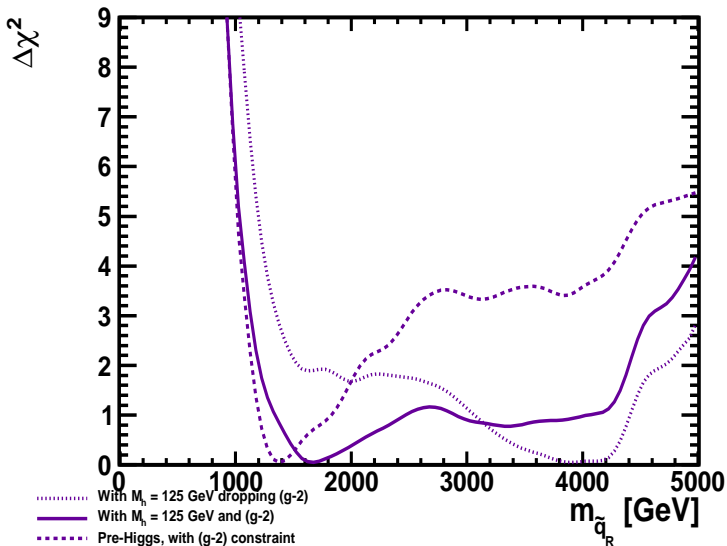
Implications: Gluino mass $m_{\tilde{g}}$

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Implications: Squark Mass in NUHM1

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Priorities for this year

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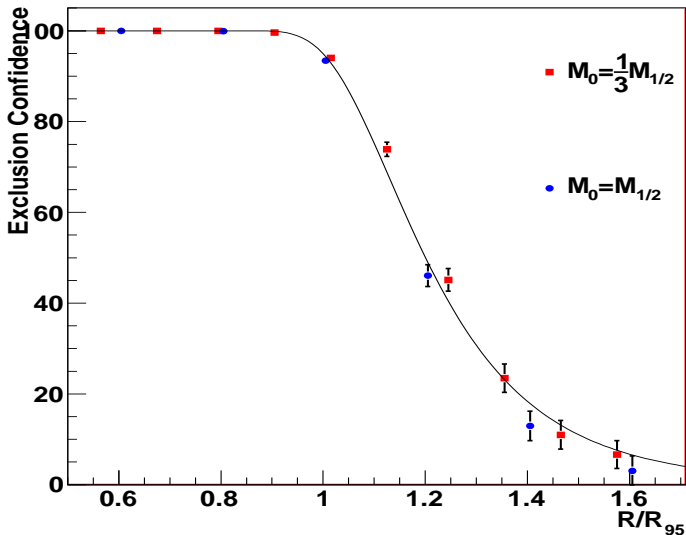
Searches

- Keeping up with experiments: Updating constraints to 7 TeV 5fb^{-1} and initial 8 TeV results
- Implementing PYTHIA + DELPHES into analysis chain
- Allows access to new models.
- Can derive and validate empirical likelihoods for SUSY searches
- So far: CMS α_T and ATLAS 0-lepton implemented and validated.

Validation of Jets+MET Empirical Likelihood Function

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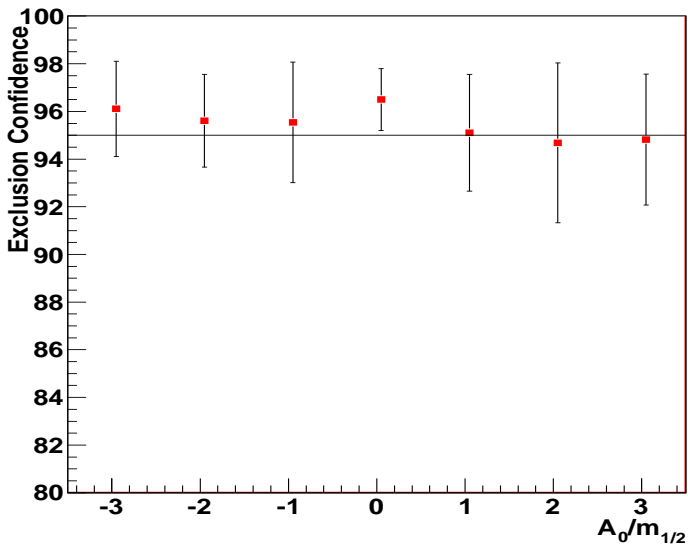
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Validation: A_0 (in)dependence

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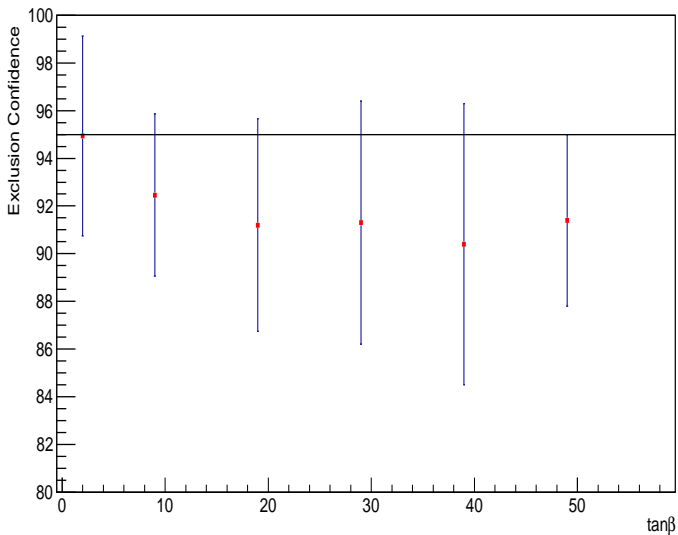
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Validation: $\tan \beta$ independence

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Priorities for this year

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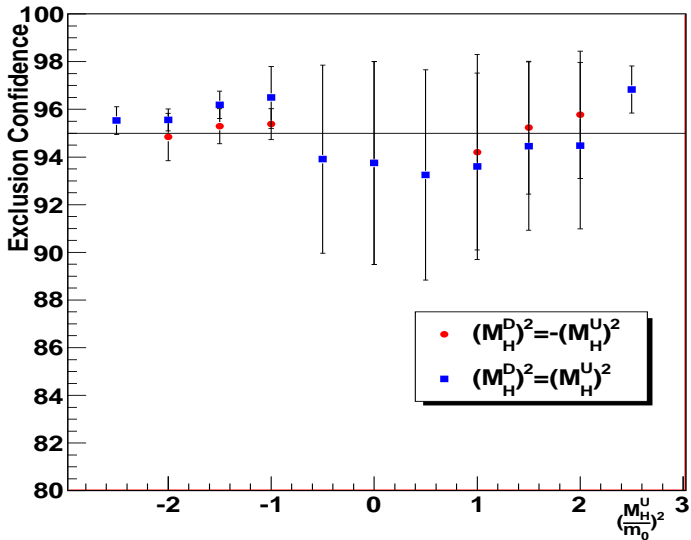
New Models

- Non-Universal Higgs Model: Access to most general Higgs phenomenology
- More general non-universal models, pMSSM.
- Look for holes in parameter space
- Likelihood allows prioritising of new analyses.

Extension to NUHM2: $m_{H_u}^2$ & $m_{H_d}^2$ independence

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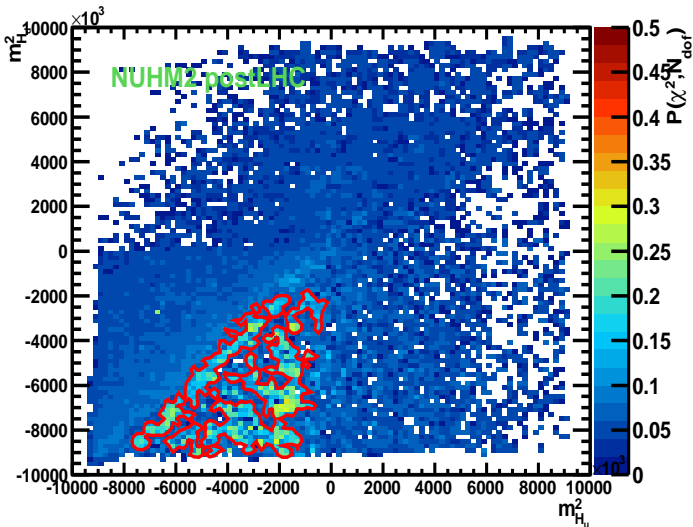
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Work in Progress: NUHM2

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Summary and Priorities

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Fits

- Incorporating 5fb^{-1} data a priority
- Extension to other models and validation
- Focus on Higgs phenomenology
- Natural SUSY fits?
- Decouple strong and weakly interacting sectors?