Implications of SUSY Searches at the LHC for the LC

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Main idea of SUSY analysis:

Combine all existing precision data:

- Electroweak precision observables (EWPO)
- B physics observables (BPO)
- Astrophysical data (CDM, DD)
- LHC searches for SUSY

Predict:

- best-fit points
- ranges for Higgs masses
- ranges for SM parameters
- ranges for SUSY masses

$\Rightarrow$ LC implications

The models: 1.) CMSSM (sometimes wrongly called mSUGRA):

$\Rightarrow$ Scenario characterized by

$$m_0,\ m_{1/2},\ A_0,\ \tan\beta,\ \text{sign}\,\mu$$

m_0 : universal scalar mass parameter

$m_{1/2}$: universal gaugino mass parameter

A_0 : universal trilinear coupling

} at the GUT scale

$\tan\beta$: ratio of Higgs vacuum expectation values

The models: 2.) NUHM1: (Non-universal Higgs mass model)

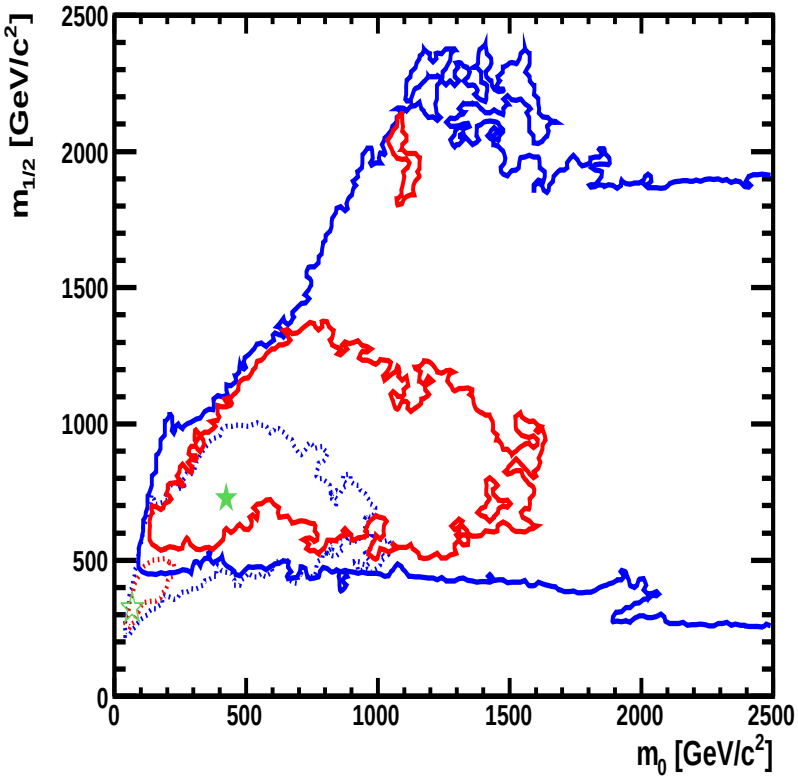
Assumption: no unification of scalar fermion and scalar Higgs parameter at the GUT scale

$\Rightarrow$ besides the CMSSM parameters: M_A or μ

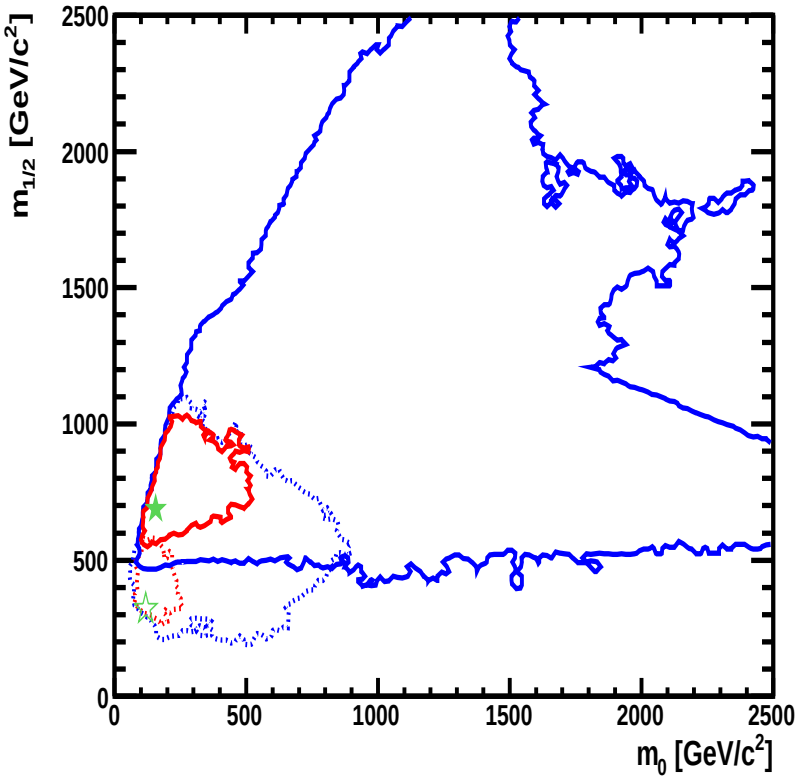
m_0-$m_{1/2}$ plane:

[2011]

CMSSM



NUHM1



dotted: pre-LHC/Xenon, solid: post-LHC (1 fb^{-1})/Xenon

$\Rightarrow$ new best-fit point within old 95% CL area

$\Rightarrow$ hardly any overlap between old and new 68% CL areas

$\Rightarrow$ shift to higher masses

What is happening to the χ^2?

Low energy data (mostly $(g-2)_\mu$) favors low SUSY mass scales

LHC data favors higher (colored) SUSY scales (1./2. gen., $m_{\tilde{g}}$)

$\Rightarrow$ tension, reflected in rising χ^2:

Model	Min. χ^2	Prob.	$m_{1/2}$ (GeV)	m_0 (GeV)	A_0 (GeV)	$\tan\beta$	$M_h^{\text{no LEP}}$ (GeV)
CMSSM	22.3/20	32%	360	90	-400	15	109
LHC$_{1/\text{fb}}$	29.3/22	14%	780	450	-1100	41	119
NUHM1	20.8/18	29%	340	110	520	13	119
LHC$_{1/\text{fb}}$	27.4/21	16%	730	150	-910	41	119

Probabilities still ok, but this might change with more data.

Not finding SUSY early does not make the ILC looks bad,
makes some very constrained models look bad!

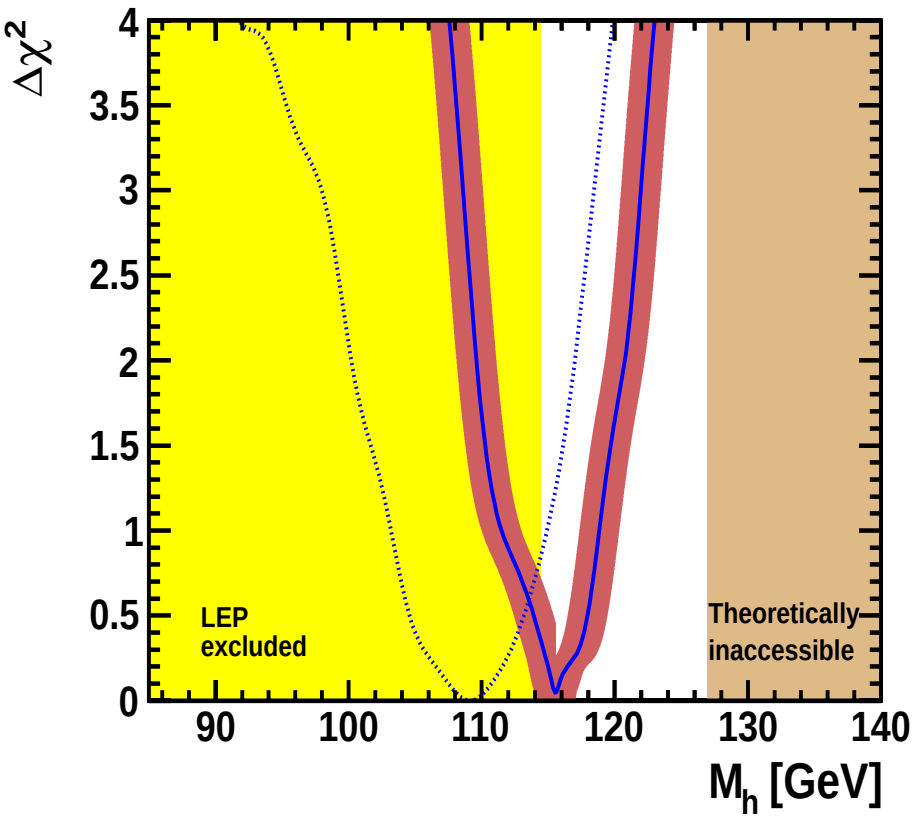
The LHC searches (mainly) for colored particles,
the ILC is (also) searching for uncolored particles!

Any inference from one sector to the other is strongly model dependent!

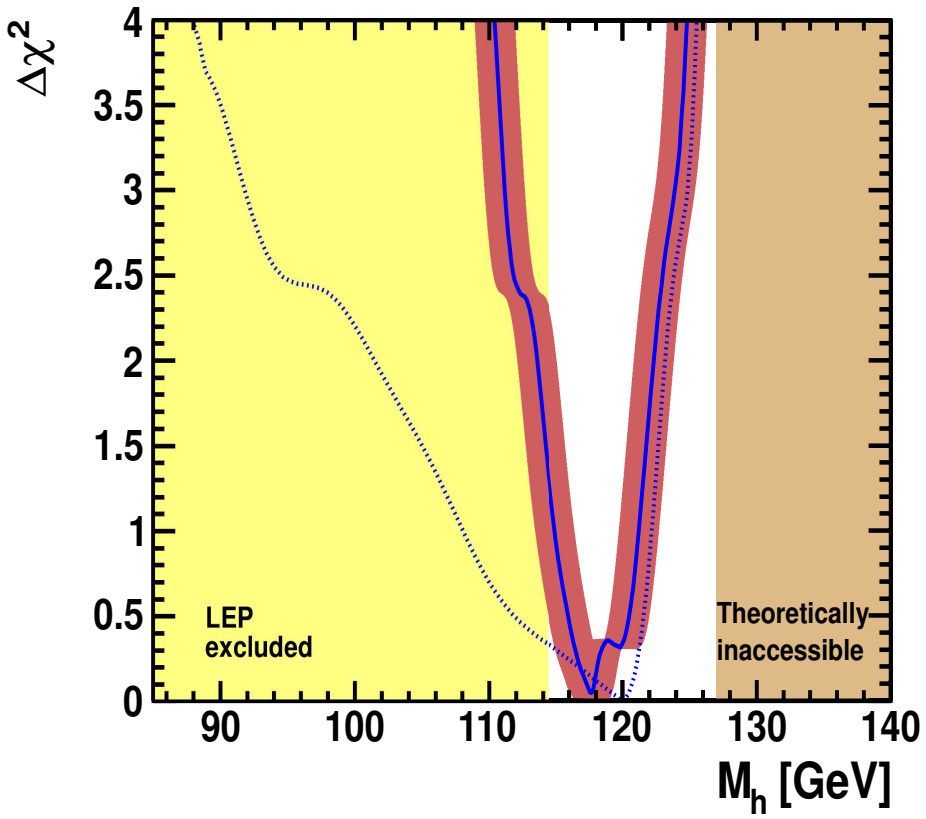
M_h prediction: post-LHC (35 pb^{-1}) red band plot:

[2011]

CMSSM



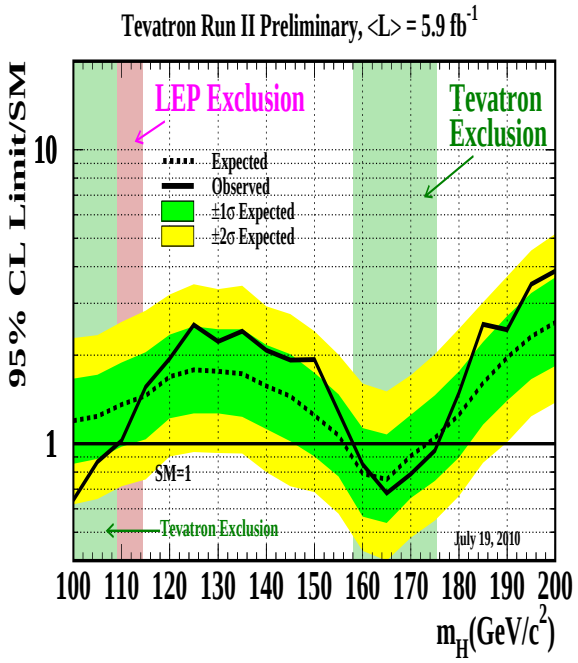
NUHM1

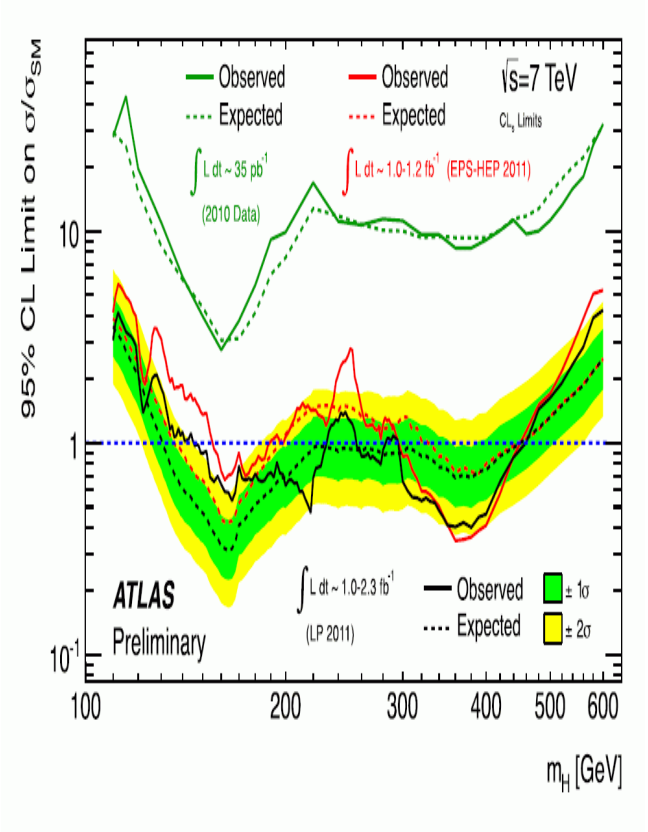


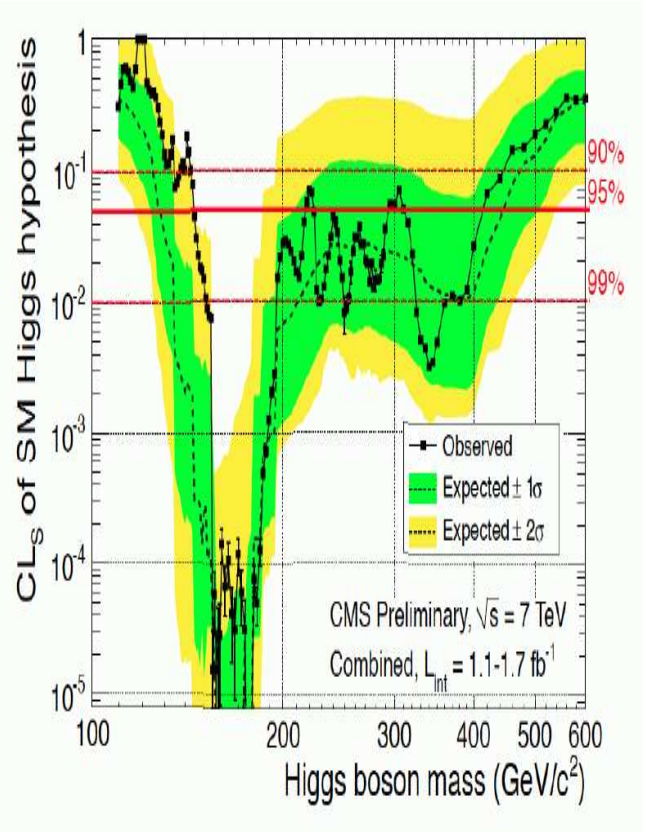
$M_h = 116 \pm 4\,(\text{exp}) \pm 1.5(\text{theo})$ GeV $118 \pm 3\,(\text{exp}) \pm 1.5(\text{theo})$ GeV

$\Rightarrow$ LEP bounds evaded! Light MSSM Higgs looks very good!

Direct Higgs searches at Tevatron and LHC:







⇒ everything points towards a low mass Higgs

⇒ low energy e^+e^+ collider IDEAL to study this scenario

We have to be prepared!